LY 1947
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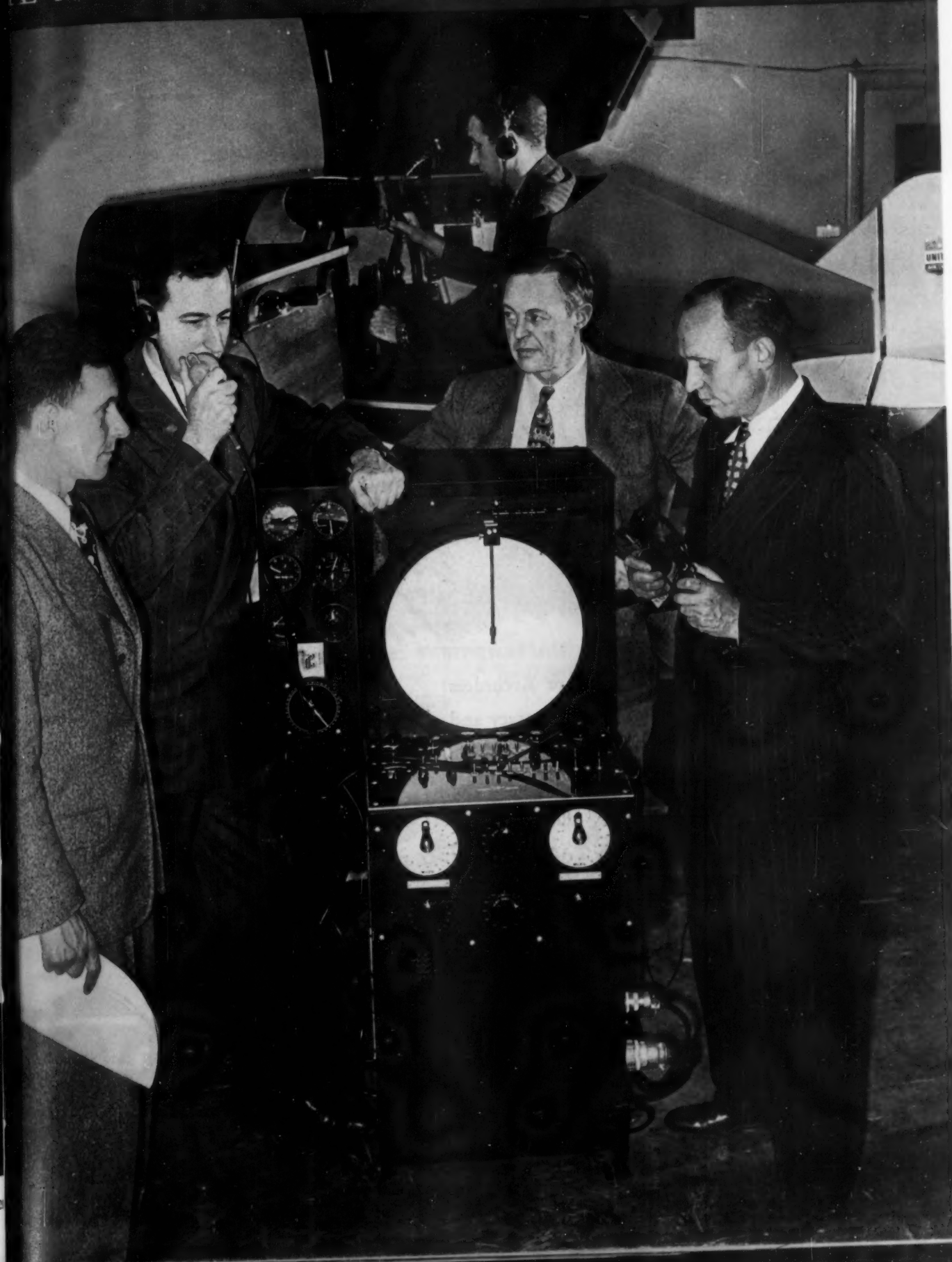
Instruments

IE MAGAZINE of MEASUREMENT and CONTROL



Pittsburgh 12, Pa.

TAG Temperature and Pressure Recorders have been a yardstick for quality, accuracy and ruggedness for many years. They are available in many types, each helping to lower processing costs through better processing efficiency. You are invited to correspond with TAG engineers on the best way to solve your temperature and pressure problems. Write today for the TAG Recorder Catalog.

THERE'S A **TAG RECORDER** To Fill Your Requirements

TAG Temperature Recorders are available in a wide variety of ranges, with 9, 10 or 12-inch charts. There is a TAG Recorder to fit the requirements of any industrial application.

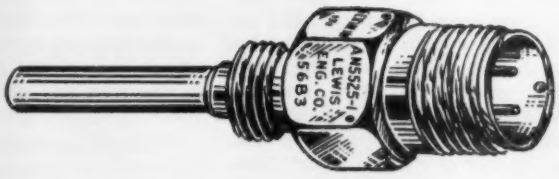
TAG Pressure Recorders cover the full range of pressures. Springs are available in bronze, steel, stainless and other alloys suited to the service requirements.

TAG

C. J. TAGLIABUE MFG. CO.

Subsidiary of Fortnightly Publications Corporation
545 Park Avenue Brooklyn 5, New York

— THE LEWIS RESISTANCE BULB —



MODEL 56B3
(AN5525-1)

THE LEWIS RESISTANCE BULB MEETS EXACTING SPECIFICATIONS

✓ **RESPONSE TIME** — Averages 5 seconds from 100°C to 10°C when taken from boiling water to an ice bath.

✓ **HERMETICALLY SEALED** — Silver Soldered Assembly, by means of modern induction heating methods. The Terminal Pins are sealed in glass to the metal cap as in electronic tubes.

✓ **HIGH TEMPERATURE OPERATION** — Built to withstand a test temperature of 300°C for one minute. Bulbs model 56B5C and 56B6 will withstand operating temperatures of 500°F for a minimum of 500 hours. Model 56B6D will withstand 300°C for a minimum of 8 hours.

✓ **TOUGH** — Built to "take it" of Stainless Steel. The stem is of 18-8 type 304 (AMS5560A) and the head is constructed of Type 303 (AMS5640B). Polarizing Pin is of unique construction to prevent bending, twisting, or becoming loose.

✓ **STANDARDIZED RESISTANCE Vs. TEMPERATURE** — The resistance - Temperature characteristics meet "AN" specifications from —70°C to +200°C, and have been extended to 300°C.

✓ **ACCEPTED AS STANDARD BY LEADING AIRFRAME MANUFACTURERS** —

These Bulbs are used as standard equipment on the following Aircraft:—

BOEING STRATOCRUISER 377

CONSOLIDATED 240

DOUGLAS DC-6

LOCKHEED CONSTELLATION 49

MARTIN 202 and 303

REPUBLIC RAINBOW RC-2

THE LEWIS ENGINEERING CO.

Specialists in Engine Temperature Measurements

• NAUGATUCK, CONNECTICUT. •

• POTENTIOMETERS • • • • • • SELECTOR SWITCHES • • • • • • • • • THERMOCOUPLES •
• PYROMETERS • • • • • • RESISTANCE THERMOMETERS • • • PROTECTION TUBES •

FANTASY

A Reunion at the 1977 Instruments Convention

By H. S. FAIRCHILD, Boston

Scene: Chicago. The new (1975) Stevens Hotel. In the mammoth West Room are some 200 display booths lined with instruments of every manufacture and for every conceivable purpose.

In front of one booth stand two elderly gentlemen. One speaks:

"Let's go in here, Jim. I used to know some people at the main office of this outfit."

The man addressed as Jim stepped back a pace or two and, looking up, saw a large sign atop the booth:

THE CROWN INSTRUMENT COMPANY

Underneath, in smaller letters, a slogan spelled out: c r o w n c o n t r o l s t h e u n i v e r s e .

"Humph! I wonder what Old Mother Nature will say about this."

Jim took his companion by the arm and continued.

"All right John, let's go in and see what's new."

Together they approached the booth and stepped up on the platform. A young man, all attention, came over immediately and took a swift glance at their convention badges.

"Good evening, gentlemen. I see your names are James Klinger and John Freeman. It's good to see you. My name is Jules Vernier."

As they shook hands, the younger man steered them to comfortable chairs. Then he disappeared behind a curtain saying, "Will you sit here a moment? There's someone I'd like you to meet."

He returned immediately leading a well-preserved man of perhaps 65.

"Gentlemen," he said, "This is Mr. George Beckwith of our International Office. I believe you and he are old friends."

"Why, George, you old sonofagun. You don't look a day over 80," said John, clapping him gayly on the back.

Jim shook hands with George, then slyly asked him where the hell the company had got the idea for that slogan he'd seen out front.

"Oh! That!" George laughed and pointed to himself. "Believe it or not, that was my idea. You knew, of course, that our instruments are now used to guide interplanetary rocket ships."

"No," said Jim hesitatingly.

"That's the trouble with you, Jim," chimed in John. "You think only in terms of your stinking chemical plants. Now, you take my hobby, instruments for the home . . ."

"By the way, John," said George, "the mention of your hobby reminds me. Do you remember that series of designs you sent us some years ago?"

John nodded eagerly.

"Well," continued George, "we have them all developed and are about to put them on the market. They are all rigged up in a model house which I will show you later. When you sent them in, they were so far ahead of demand that we couldn't use them, but now, with the public learning more about instrumentation, there is a definite trend in that direction. Probably be a tidy sum in it for you. But first, you must see our new 'Mono-chart Deca-motron.' Please sit here a moment while I turn the switch."

John and Jim took chairs facing a large silver screen. Almost immediately, it seemed, the bright lights dimmed and a spot of colored light appeared in the center of the bright background. As George adjusted the dials in a control booth nearby, the spot grew and expanded into a full color picture filling the entire surface of the screen.

"Where was that p i c t u r e taken, George?" asked Jim.

"That is not a picture in the usual sense," replied George, "It is a pick-up from a continuous transmitter outside of a plant area in Southern Morania. This plant was completed only two months ago. Now watch!"

The picture changed rapidly. First a close-up of the main buildings, then the steel structure supporting the tall columns, next the rows of pumps, then a far-away view showing the myriad lines i n t e r c o n n e c t i n g the welter of equipment. Finally the scene shifted to the interior of the control house.

In the center of a large bare room stood a black steel box-like object about two feet square and six feet high. At eye height in one side of the square, was a single 12-inch strip-chart recorder. As they watched, the chart grew larger until they could see dozens of lines drawn simultaneously on this single chart.

"Why, George," shouted Jim, "don't tell me that this one instrument is all there is to this plant. A plant of that size used to take a control room five times as large as the one you show here, with instruments filling a U-shaped panel board on three sides of the room." And Jim shook his head incredulously.

John noticed the absence of personnel and asked his host about it: "George, with this continuous photo-transmission system, aren't the operators afraid they'll be caught off their jobs? I haven't seen one yet."

George pointed to the screen.

"You old-timers did a good job in your day, but today *there is no need for operators.* The instrument you see there records the amount and quality of three final products. Through continuous sampling devices, a close quality check is maintained. If any product stream shows off-specification, beyond acceptable limits, that stream is automatically by-passed to an intermediate tank, while the central controller repositions a group of local controls to bring the stream back to normal. When the sampler again shows the stream to be acceptable, it is allowed to flow to the normal product tank. The off-color rejected product is then introduced in small quantities somewhat further back in the process, so that it eventually becomes part of the final product. Levels in the feed and product tanks regulate the rate of throughout."

"That," concluded George, "is our Mono-chart Deca-motron, gentlemen. How do you like it?

Jim shook his head sadly, and said, "I suppose it's a great step forward, but I remember that the instruments we used to know about were not to be trusted. They had to have operators to watch them and to by-pass controls when something went wrong. Then there were the Instrument Repairmen who would come and check the cause of the trouble and make repairs."

"By the way," he added querulously, "What has happened to the Instrument Man in this new régime?"

George explained: "This whole business started years ago, when one instrument man asked himself why there were so many alarm points on a control panel. The more he thought about it the more firm became his conviction that instead of having an alarm sound when something went wrong, an instrument should be added to correct the situation. At first he had trouble selling the idea to the men in charge of operation, but later he was allowed to test his theory. The net result was that the cost of instrumenting a plant rose, but the number of hours continually on stream was increased beyond all expectation. Operators became necessary only at start-up or shut-down time. Then with a few deft twists of the imagineering wand, even these functions could be made to follow the flip of one switch. At first, this integrated control could only be applied to processes where the liquids involved were relatively clean, and not corrosive. Eventually, however, production and quality figures began to show such an improvement that research groups were directed to find ways around any and all difficulties that stood in the way of complete integration of process control."

"Actually, our centralized controller which you see here, could never have been produced if it were not for the adoption of completely integrated control as a definite policy of operation."

"Periodic shut-downs still occur, however, as they must, but the day of 'spot calls' for instrument maintenance men is definitely a thing of the past. The main function of the instrument man is now that of 'living with' new plants until the bugs are ironed out. After

EDITOR'S NOTE—Mr. Fairchild's manuscript was received in November 1946. Reason for mention: centralized control with features he describes was proposed (via newspaper publicity) two months later at the AIEE New York meeting. Mr. Fairchild deserves credit, for he was abroad when the scheme was first proposed (at the "Manless Factory" ACS session) in 1942.—MFB

For Precision Measurement Across the Board

There's hardly a field of research or manufacturing where the W & T Precision Dial Manometer doesn't mean faster and more accurate pressure measurement at lower cost. It's a direct reading aneroid type precision indicator individually calibrated to your requirements and is equally suited for instrument calibration or test and operational studies. Leading automotive, aircraft and research organizations have found it invaluable for gas turbine testing, balance diaphragm torque and thrust stands, wind tunnel investigations and in many other fields where precise pressure measurement is required.

Can your work use these characteristics of the Precision Dial Manometer?

RANGE . up to 200 inches of Mercury
SENSITIVITY . . . . 1 part in 10,000
ACCURACY . . . . . 1 part in 1,000
DIAL . . . . . 8½″ diameter
SCALE LENGTH . . . . . 45 inches
CALIBRATION . . any desired pressure graduation

WALLACE & TIERNAN
PRODUCTS, INC.

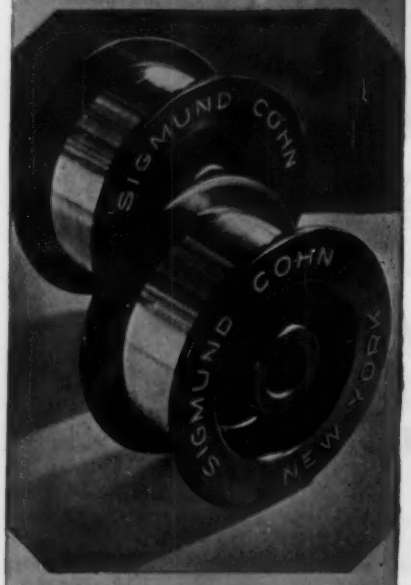
Manufacturers of Electrical Mechanisms and Precision Instruments
Belleville 9, New Jersey • Represented in Principal Cities

A-66

PRECIOUS METALS

PLATINUM METALS

GOLD ALLOYS



SHEET
FOIL
RIBBON
WIRE
TUBING

WRITE for list of products

SIGMUND COHN & CO.
44 GOLD ST. NEW YORK
SINCE 1901

that, he is usually present at periodic shut-downs only."

"The instrument engineer has long since moved into the same office with the process engineer. Together they turn out plants which are functionally designed for instrumentation. Years ago, plants were designed 'process-wise' and, at a later date, instruments were hung on—here and there. It has taken a long time, but we believe that now instruments are doing the job that they were intended to do and should have been doing for years."

At this point, John broke in: "George, that's wonderful. Now let's go see these gadgets for the home you were telling me about."

George turned a switch: the picture faded and the lights came on.

The trio started, somewhat stiffly, down the aisle to another booth where the Crown Company was exhibiting Instruments for the Home.

Set up amid the garish display of other products was an up-to-date house of five rooms. Its windows, all wide, were made of clear plate glass, sealed in place. The entrance comprised two doors: a kind of air lock. As one entered, one door had to be closed before the other was opened, for this was a pressurized house.

George then explained the features which made the house so pleasant.

"You are in an atmosphere about half an inch of water-column pressure greater than the outside. All air is brought in from outside—cooled or warmed depending on the need, moistened or dried to the optimum humidity, stripped of dust and pollen by an electrostatic dust catcher, and ionized to complete the conditioning. A portion of the air is recycled to the entrance to save heat; the rest is allowed to escape through a back-pressure valve in the roof."

Finally, Jim nudged John: "You had a hand in this?"

John answered, "Sure—my hobby!"

Jim, the irrepressible, stated dryly, "We've been threatened with it many years, but no one has yet figured out a better way to have babies, thank God!"

"Come on, you old reprobate," ordered John, "before you get us tossed out on our ear."

In a moment the two old gentlemen had said their good-byes and were shuffling down the brilliantly-lighted aisle toward the many other exhibits. Each booth seemed to beckon as they passed. But they were tired old men. They had had a good full life. Each year they expected would be their last to see the "Big Show." Yet each year found them hoping to see yet another.

As they passed through the outer door, they turned and looked back.

John said, "It's been a good life, this instrumentation game."

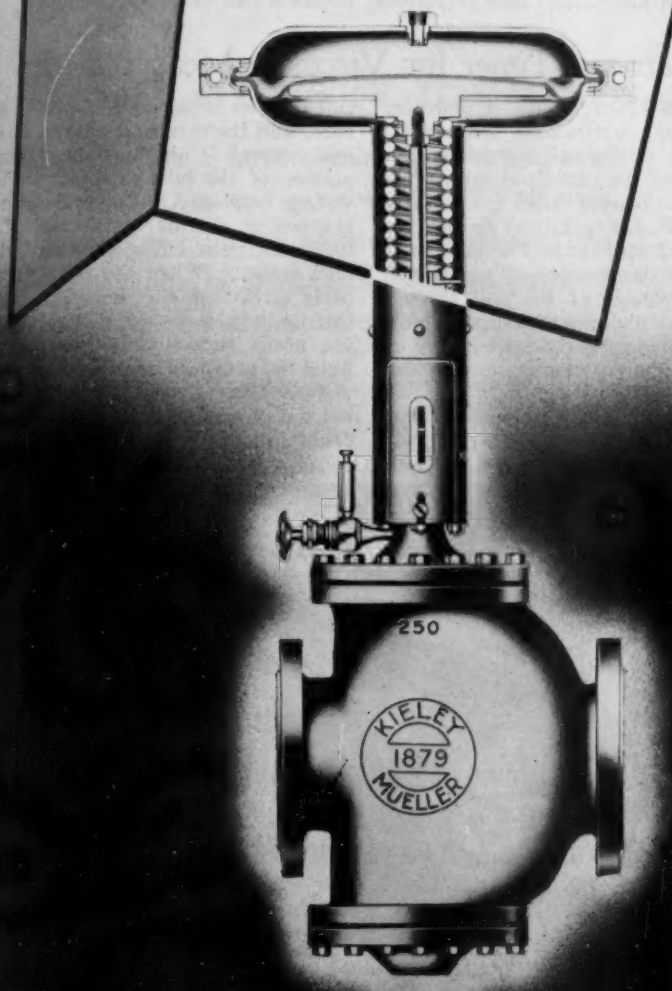
Then as arm-in-arm they entered the lobby, Jim was heard to mutter: "Crown controls the universe, Eh?—Well, that beats me!"

Drawn by
J. M. DAILEY
Lake Charles, La.

"And this little gear is the only part that could give you any trouble."

IT'S AN "OPEN AND SHUT CASE"

for K & M's Revolutionary KONTROL MOTOR DIAPHRAGM VALVE



Just two simple quick-acting clamp screws to loosen, and your diaphragm casing is off. Tight-sealing clamp ring eliminates multiple bolts completely. Duo-seal molded diaphragm lips are automatically self-sealing.

67 years of control engineering "know how" produced this revolutionary new KONTROL MOTOR . . . featuring these design innovations:

- Pressed Steel Diaphragm Casing . . . lighter . . . tougher, more durable.
- Rigid Welded Steel *Tubular* Yoke.
- Long calibrated Steel spring . . . fully enclosed.
- Enclosed ball bearing Spring Adjusting Screw.
- Streamlined Flow Valve Body with high capacity . . . unrestricted flow areas.
- Super-finished Disc Guides, *honed* guide bushings, top and bottom . . . for minimum friction; increased life.

Used with air operated instruments or auxiliary pilot units, the K & M KONTROL MOTOR regulates the flow of steam, liquids or gases — efficiently and sensitively. Send us your control problems. We'll show you how the KONTROL MOTOR valves will solve them. Write for new KONTROL MOTOR bulletin.

KONTROL KIELEY & MUELLER MOTOR

REPRESENTED IN

New York City, Detroit, Cincinnati, Houston, Los Angeles, Rochester, Pittsburgh, Tulsa, New Orleans, San Francisco, Philadelphia, Chicago, Baltimore, Dallas, Denver, Portland

KIELEY & MUELLER, INC., North Bergen, New Jersey

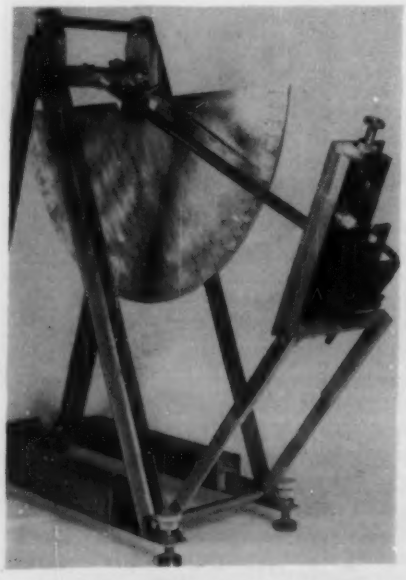
INSTRUMENTS ON THE MARCH

Measurement of Slipperiness of Walkway Surfaces

WASHINGTON, D. C.—To minimize hazards of slippery walkway surfaces, a joint research project has been undertaken by the National Safety Council and the National Bureau of Standards directed toward developing safety codes for walkways and footwear.

The establishment of safety codes for walkway surfaces and footwear has been materially handicapped by the lack of adequate methods of measuring slipperiness. Most of the devices used in the past were more representative of a person standing on a floor than of someone walking.

As an aid in the design of testing instruments, the NBS is making a study of walking habits. Concealed cameras



Portable impact-type slipperiness tester designed and constructed at the NBS for measurement of the relative slipperiness of different walkway surfaces for various types of footwear.

have been used to take slow-motion pictures of people walking in their usual manner, while they were unaware of being photographed.

It is extremely difficult to reproduce artificially, in the laboratory, walkway surfaces that are typical of the various conditions in service, because the location of a floor determines to a large extent the texture of its worn surface. Accordingly, P. A. Sigler of the NBS has designed a portable impact-type slipperiness tester that can be used to test floors in actual service. The design is based on the premises that slipping is a function of two surfaces and that in the process of ordinary walking slipping is most likely to occur when the walkway surface is first contacted by the rear edge of the heel.

The instrument is primarily a compound pendulum which sweeps a shoe material over the walkway surface to be tested. A mechanical shoe forms the lower end of the pendulum and is so arranged that a 1½" square test piece of rubber, leather, or other heel material can be attached to the underside of the shoe at various angles so that only the rear edge of the test piece makes contact with the walkway surface. A helical spring is used to press the edge of the test piece against the walkway surface during contact. The pendulum is released at a fixed height and the edge of the heel is permitted to sweep over the surface of the floor specimen. A pointer attached to the framework at the center of oscillation of the pendulum indicates on a scale the maximum height to which the pendulum rises above its lowest position. From this information an "antislip coefficient" for the walkway and footwear surfaces can be computed.

Electronic Timer for Viscosity Measurements

WASHINGTON, D. C.—A new electronic timer, particularly adapted for use with a falling-ball viscosimeter in the study of the rapidly-changing viscosity of an opaque fluid, has been designed by P. J. Franklin of the National Bureal of Standards. The instrument comprises pulse-sharpening and trigger circuits. Passage of the ball through two coils around the viscosimeter tube is used to trigger a radio-frequency oscillator, starting and stopping a timing device.

The comparatively simple circuit utilizes the r-f. induction field. The output of a 1400-kc. crystal oscillator is link-coupled to the start and stop coils surrounding the viscosimeter tube. No buffer amplifier is required. A small padding capacitor is placed across each coil, so that the amount of detuning is the same in both coils as a steel ball falls through them, changing the inductance of each coil in turn.

The r-f. power from each coil is rectified in the separate diodes of a 6SQ7 tube, and the resulting change in cathode current is amplified in the triode portion of the tube to obtain sufficient voltage variation to operate a pulse-sharpening circuit consisting of two 0.04-watt neon bulbs in series with a load resistor. When the voltage in the plate circuit of the amplifier rises to the ignition point of the neon tubes, the neons suddenly fire and a sharp pulse is produced across the load resistor. These tubes have a small amount of radium added to provide uniform ignition voltage regardless of illumination. Once ignited they stay ignited until the output voltage of the triodes has dropped to a low value, allowing only one pulse to occur with passage of the ball through each coil. Both pulses are placed on the grids of a trigger pair which, on the first pulse, closes a relay that starts a clock and, on the second pulse, opens the relay to stop the clock. Time of fall, as meas-

Timing a falling-ball viscosimeter by means of the new electronic timer (at right) developed at the NBS. The output of a crystal oscillator is link-coupled to the two coils encircling the tube of the viscosimeter (within the constant-temperature jacket adjacent to the timer).

4+8=100,000

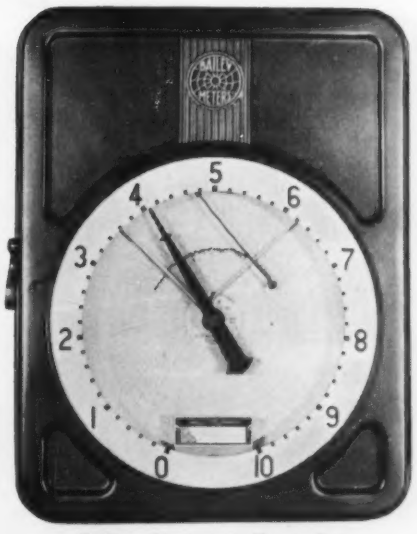
What does it mean?

Just this—with 4 basic circuits and 8 basic component parts you can get over 100,000 different combinations of Bailey electronic instruments and controls for flow, temperature, level, speed, gas analysis, etc. Furthermore, parts are interchangeable.

Look how this simplifies your instrument problem. By specifying Bailey, you automatically reduce your stock of replacement parts. You begin to standardize your instruments as you do other equipment in your plant. And that means reduced maintenance costs.

Maintenance men need less training—they quickly become familiar with the standardized Bailey parts—no time is lost in exploring a multiplicity of specialized equipment. For example—the amplifiers, slidewire units, and other basic components are standard for all combinations of Bailey electronic instruments.

Write today for bulletin 17. You should have a copy in your file for ready reference the next time you specify process controls. Meanwhile, remember—4 plus 8 will give you over 100,000.



Bailey Electronic Recorder

Save 3/4 OF YOUR PANEL SPACE

This is typical of the advantages you get with Bailey instruments and controls. The 4-pen Pyrotron makes the same number of continuous records as four separate recorders. Each pen is actuated by a separate system. It draws a continuous record in a distinctive color. Package units are interchangeable. Our bulletin 230-A describes this space-saving unit in detail.

P-13

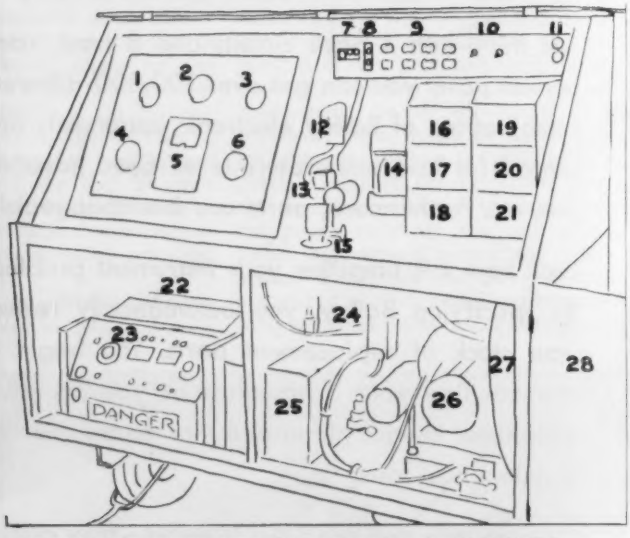
BAILEY METER COMPANY
1041 IVANHOE ROAD
CLEVELAND 10, OHIO

Controls FOR THE PROCESS INDUSTRIES

Temperature • Pressure • Flow • % Oxygen • % Combustibles • Level • Density • Ratio

Transportable Electrical Aircraft Analyzer and "Service Station"

WILMINGTON, Ohio. — Two AAF civilian employees at Clinton County Army Air Field, P. G. West and Glynn Hoover, got tired running out on the line to diagnose trouble with small testing instruments and then returning to their shop for more instruments and other equipment, so they developed a portable "one-stop" electrical service station for all planes on the field. This consists of a three-wheeled cart that can handle any repair or installation emergency. It has been estimated that 50% more work can be accomplished by the use of this instrument-studded cart on the All-Weather Flying Center's diversified planes. The larger photograph shows the portable analyzer and service station being rolled out to the "work-horse," Fairchild's renowned C-82 packet. The smaller photo and sketch show instrumentation details.



AAF's PORTABLE "ONE-STOP" ELECTRICAL SERVICE STATION FOR AIRPLANES AND LIST OF COMPONENTS

1. A-c voltmeter
2. Frequency meter
3. D-c voltmeter
4. A-c ammeter
5. Multimeter (measures ohms, a-c volts, d-c. volts, milliamperes and signal output voltages)
6. D-c ammeter
7. Starting and stopping controls for 12-volt d.c. and 110-volt a.c. power plant
8. Starting and stopping controls for 24-volt d.c. power plant
9. Set of receptacles represent 12- and 24-volt d.c. and 110-volt a.c. power outlets. Each outlet has a pilot light to indicate whether power is on or off.
10. Test switches to test relays
11. Four sockets to test standard-type bulbs used on aircraft
12. Aircraft reverse current relay
13. Carbon pile voltage regulator
14. Lug soldering transformer
15. Bench vise
16. Drawer for grommets
17. Drawer for lamp bulbs
18. Drawer for switches, clamps, fuse posts
19. Drawer for safety wire, solder and paste, spaghetti stakons
20. Drawer for terminals
21. Drawer for fuses
22. Behind harness tester (No. 23) is a 12-volt battery
23. Ignition Harness tester—20,000 volts
24. 110- and 12-volt gasoline power unit
25. 24-volt battery
26. 24-volt gasoline power unit
27. Aircraft energizer extension line
28. Extension Cord

Note: Behind the upper left-hand instrument panel is a storage place for an extra supply of spare aircraft parts.

ured with this circuit for one direction of travel, was found to be reproducible with 0.01 second for a fall time of 2.5 seconds.

While various electrical methods employing the conductive or magnetic characteristics of the falling ball had previously been used to measure its time of travel, none of these methods was considered completely satisfactory, owing to lack of sensitivity, poor reproducibility of results, or the complicated nature of the circuit required. The induction method used in the timer proved to be the answer to the problem.

Microhardness of Steel

KEARNY, N. J.—The hardness of microscopic grains in a piece of steel can be measured by a new device designed at the Research Laboratory of the U.S. Steel Corp. Still more minutely, the new microhardness tester can gage the hardness of a single steel grain at as many as three points within the breadth of a human hair.

Like other traditional hardness testers, but on a much finer scale, the Kearny device operates by indenting the polished surface of a steel sample. Its diamond-point penetrator, under a load of a few grams, leaves a square mark which can rarely be seen by the naked eye. The diagonals of this tiny square indentation are measured in microns. (A micron is 0.000039".) This reading is related to the load placed on the penetrator so that hardness may be computed.

The operator of the microhardness tester places the carefully-polished sample under the microscope on a movable bed plate and selects the grain or area to be tested. When this is deter-

EASIER TO CARRY THAN AN OUTBOARD MOTOR

THIS FULL-FLEDGED, *Portable Flow Meter* Weighs only *35* Pounds

The Foxboro Portable Flow Meter is equipped with a 5-valve piping manifold; the two extra valves serving to prevent loss of mercury during transportation. The mechanism chamber has a special shipping stop which operates through a stuffing box to clamp the float while meter is carried.

Other exclusive Foxboro Refinements . . . *Sure-Seal Check Valves* positively prevent mercury losses; *Pressure-Tite Bearing* eliminates stuffing box and packing; *Float in High Pressure Chamber* minimizes temperature errors.

Portable Flow Meter Installation on Portable Well Tester

NO WONDER there are so many of these portable flow meters in use! They're designed for portability . . . light, easy to lift and lug . . . yet they're full-sized, standard Foxboro Instruments. These instruments are primarily used for measuring and checking service on pipe lines.

Although they weigh only 35 pounds, they're ruggedly constructed. Their frames are of stout aluminum . . . well-balanced . . . and sturdily supported. Meter chambers are forged steel for 500 or 1000 lbs. working pressure. Differential range is 100" . . . static range as desired.

This mercury float type differential meter affords the best possible protection against overranging and loss of mercury. It is least subject to errors caused by temperature changes. Its calibration is simple . . . testing and checking are less frequently required because there is no occasion for spring-fatigue. Get all the facts. Write **The Foxboro Company, 46 Neponset Avenue, Foxboro, Massachusetts, U. S. A.**

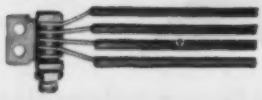
FOXBORO
REG. U. S. PAT. OFF.

DIFFERENTIAL-TYPE FLOW METERS

BRADLEY

COPPER OXIDE RECTIFIERS

INSTRUMENT RECTIFIERS FOR BETTER A. C. SCALE



Vacuum-processed, gold-coated, full-wave bridge, Bradley instrument rectifiers allow more accurate determination of very low A.C. current. Especially designed for use where stability and permanence of calibration are important, "Coprox" rectifiers meet the most exacting requirements. Yet they cost no more than ordinary rectifiers — in most cases, less.

Temperature error is exceptionally low with Bradley rectifiers. Aging is practically nil. Shown above, CX2E4F rated up to 4.5 volts A.C., 3 volts and 5 milliamperes D.C.

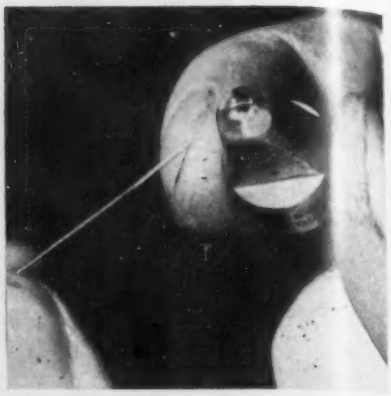
Illustrated literature, available on request, shows more models of copper oxide rectifiers, plus a line of selenium rectifiers and photocells. Write for "The Bradley Line."

BRADLEY LABORATORIES, INC.

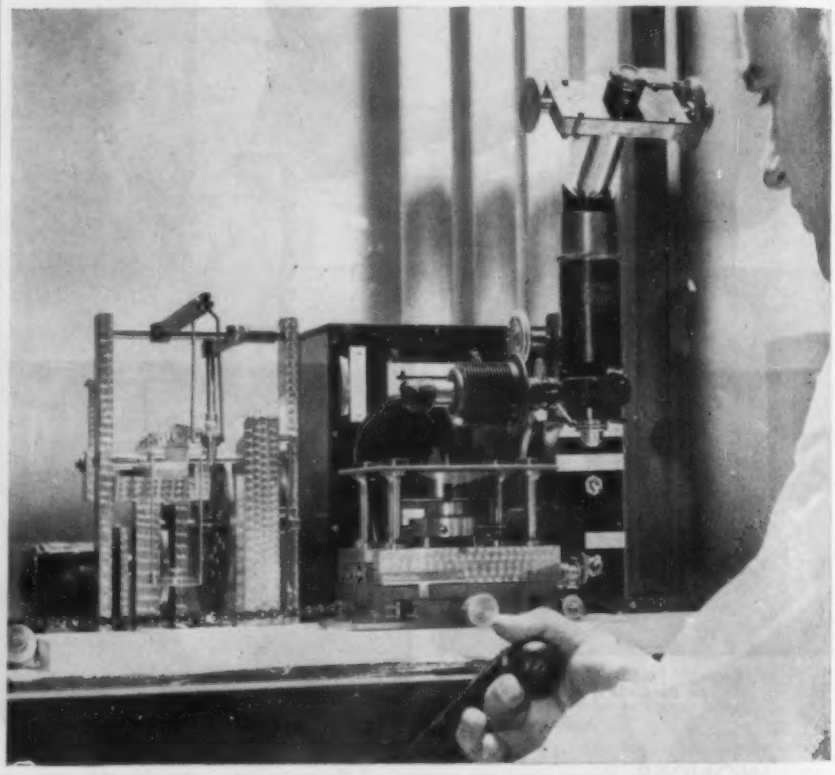
82 Meadow St. New Haven 10, Conn.

mined the sample is transferred to the penetrator mechanism. The penetrator arm, balanced with its adjustable weight suspended on knife edges, slowly bears down its weight to make the indentation. Then the sample is moved back under the microscope and the diagonal of the square indentation is measured. The device makes possible the measurement of hardness gradients within areas too small to permit satisfactory exploration with any of the usual hardness testers.

The mechanism consists of the indenter with a square-base, 136° diamond pyramid penetrator, the mechanical stage for holding the specimen, a microscope capable of magnifying the test field 500 to 1500 times, and a control box. All parts are assembled on a heavy cast-iron plate supported by steel legs which rest on insulated wooden blocks to minimize effects of vibrations present in the building. As many as sixty indentations may be made automatically at predetermined time intervals for surveying tiny gradients, which may have an important influence on the behavior of a fabricated product such as a weld.



Tiny diamond used to test the hardness of microscopic grains of steel in the Research Laboratory, U. S. Steel Corp. The pyramidal gem has a square base and is minutely cut to a 136° angle. Its wedge point is capable of making three indentations within the breadth of a human hair.



Microhardness Tester being oeprated by a staff member at U. S. Steel Corp. Research Laboratory. Instrument comprises a penetrating unit (left) and a mechanical stage (right) equipped with a microscope capable of magnifying the steel test field 500 to 1500 times. Hardness is determined by measuring the diagonals of a diamond-made indentation.

Microsecond Oscillograms Developed in 30 Seconds

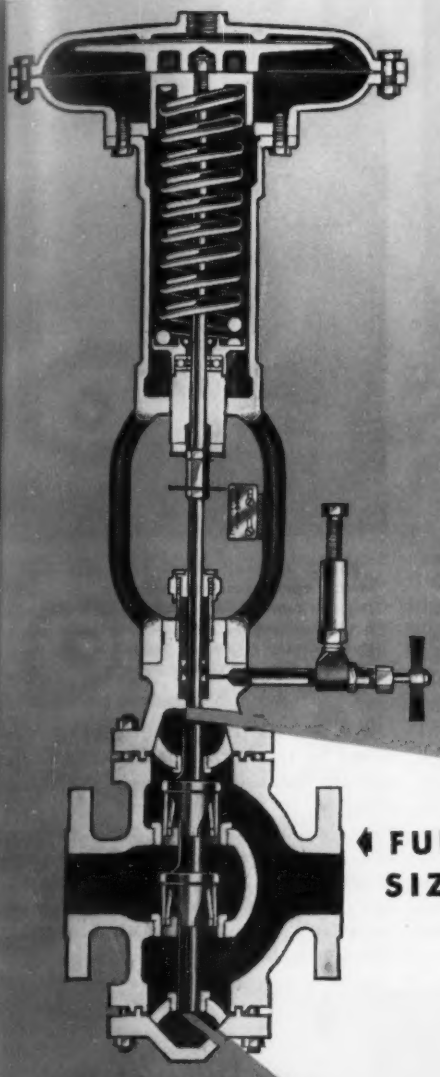
SCHENECTADY, N. Y.—A camera with a speed of one-millionth of a second which produces a finished photographic projection within 30 seconds after the picture is taken has been developed by General Electric's General Engineering and Consulting Laboratory here.

Two feet long and one foot high and deep, the camera is not portable. Fully automatic with the press of a button, it is part of equipment developed for surge testing of apparatus used in electric power generation and transmission, where it is used in combination with a cathode-ray oscillograph (see Fig. 1). Since the total duration of the recorded voltage wave may be one-millionth to a few hundred millionths of a second, the camera speed

RESTRICTED INNER VALVE PROCEDURE FOR FISHER DIAPHRAGM CONTROL VALVES . . . . . .

The introduction of Fisher's new restricted inner valves offers a quick, economical and completely satisfactory way to reduce the effective capacity of a larger nominal valve size.

INTERCHANGEABLE



FULL SIZE

1 SIZE SMALLER

2 SIZES SMALLER

PRACTICAL

For example, a 4" valve can quickly be converted to flow capacity of a 3" 2½", or 2" size. This is accomplished by the restricted V-Port Inner Valve alone—without changing seat rings. Inner valves with equivalent smaller size valve area or capacity are fully interchangeable with standard full size inner valves. Inner valve skirts are cast stainless steel with wide range percentage characteristics port areas. Cast skirts are welded on to stainless steel bar stock center post guide. Further details and application data gladly furnished on request.

FISHER GOVERNOR COMPANY MARSHALLTOWN, IOWA

FLOW RATE METER ELIMINATES "BUBBLE COUNTING"

This compact flow meter is the answer to purge line (Bubbler) control installation.

- . . . true purge rate indication
- . . . easily and neatly panel mounted singly or in multiple, requires a minimum of space.
- . . . furnished with or without needle control valve.

$9.00 per unit, without control valve (lower price when purchased in quantity).

Write for catalog 31

FLOW RATES

AS LOW AS 1 CC/MIN.

• INDICATED • RECORDED • TtotalIZED • CONTROLLED

WITH THE NEW RATO-TRONIC

The Rato-Tronic instrument electronically transmits an F & P FLOWRATOR (variable-area flow meter) float position reading to the secondary instrument and utilizes a servo motor operated without a slide wire as the power source.

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FLOWRATOR
TRADEMARK
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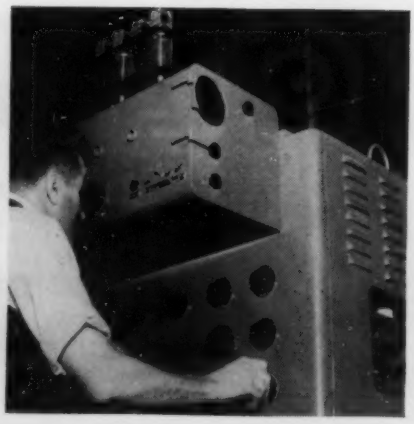


Fig. 1. Automatic camera-developer-projector (upper cabinet) being used by N. Rohats, G-E engineer who directed its development. The high-speed camera is part of the surge-testing apparatus (larger cabinet).

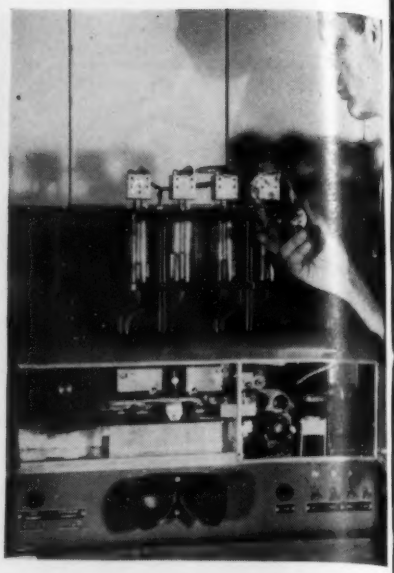


Fig. 2. Close-up of the high-speed automatic camera-developer-projector. It contains a camera which will take a picture in a millionth of a second, a rapid automatic developer and a projector. Mr. Rohats is shown pouring hypo into one of the reservoirs.

must be exceptionally high, according to Nicholas Rohats, G-E engineer who directed work on the test equipment.

As soon as the photograph is taken, the operator pushes a button, thereby setting into action the automatic developing equipment built into the camera (see Fig. 2). The development cycle is finished in 24 seconds, and the film moves into another compartment in which a projector reproduces the negative, enlarged about ten times, on a ground-glass screen at one side of the camera. This picture gives the operator an accurate record of the performance of the equipment during the application of the surge.

Mr. Rohats pointed out that the time saved by the high-speed camera is significant because of the large investment involved in the equipment under test, the oscillograph, and the associated test set, a generator which produces surges up to 3,000,000 volts. With this new equipment, testing of electric apparatus will be speeded up as much as ten times, he estimated.

HISTORIC.—At the Smithsonian Institution, Washington, D.C., the exhibit of early models of Sheffield precision measuring instruments and a pictorial history of measurements are attracting many visitors. Above, Carl Mitman, head curator of engineering and industries (left), and Dr. Alexander Wetmore, secretary of the Smithsonian, are seen viewing the display. The instruments were presented to the Smithsonian last year by Louis Polk, president of Sheffield, to inaugurate a permanent display of precision measuring instruments.

By M. F. BEHAR

On Calibrating Without a Lab

Dear Mr. T———: It is a pleasure to reply to your inquiry of June 21 regarding the calibration of "thermometers and thermocouples in the range 0°F. to 900°F." Our reply will necessarily be brief, because detailed instructions would fill a book.

From the fact that your letter is written by hand we conclude that yours is a small plant and that the addition of a thoroughly-equipped calibration laboratory is out of the question.

It seems to us that your choice of calibrating equipment should be governed by the accuracy expected from these thermometers and pyrometers after they have been in service for months or years. If you want all your temperature instruments to retain their factory calibrations after years of service, you will either have to install a calibration "laboratory" or send them out periodically to be calibrated. Price lists on various kinds of calibration services are obtainable from the National Bureau of Standards, from instrument manufacturers and from independent instrument service shops.

The expression "various kinds of calibration service," which I used above, implies that there is no such thing as just "a calibration" to be performed for you by the Bureau or by commercial establishments. That is true and it is something for you to bear in mind. For example, the literature you will receive from the Bureau will describe a dozen or more different kinds of services which it renders.

Another factor that should govern your decision is the *depth of immersion* of each thermometer stem and thermocouple assembly in the oven, vat or other apparatus where it is installed. This is an important factor and we shall discuss it separately for thermometers and pyrometers.

Thermometers. Even short-stem thermometers give different readings (for the same temperature around the sensitive portion at the end of the stem) under different conditions of installation. The calibration apparatus, therefore, should closely duplicate the conditions of permanent installation in your ovens or tanks or other apparatus, or else a correction factor should be determined.

Thermocouples. The same holds true for a new thermocouple assembly enclosed in a protection tube: the calibration equipment should closely duplicate the installation or should yield the appropriate correction factor. But thermocouples become *inhomogeneous* in actual service and this is what complicates the calibration of industrial thermocouples—even those enclosed in protection tubes. To "duplicate" the installation is well-nigh impossible because this would mean duplicating its *temperature gradients* which affect the emf. developed by any inhomogeneous thermocouple. To arrive at a correction factor is also well-nigh impossible. In general, therefore, the first thing to do in calibrating any thermocouple (other than a brand-new one accompanied by a guarantee of homogeneity) is to check it for inhomogeneities and either throw it out if very bad or "save" it if possible by cutting out the contaminated lengths and joining the severed ends by the method appropriate for the particular material. If most of your thermocouples are inhomogeneous, you need not discard all of them, or mistrust the future readings of all of them: a really expert service engineer will give you the benefit of "tricks of the trade" whereby, for the next six months or so, you will be able to have confidence in the readings of the couples he passes—*if they are not disturbed or contaminated after he leaves them.* Which brings me to the next subject.

Checking Installed Instruments. Perhaps the most practical immediate solution of your problem is to "check" your instruments, not to "calibrate" them. To me, a calibration has always meant the comparison of an instrument (or component such as a couple) against a standard or a set of standards at a number of points throughout its range. Such true calibration is necessary for a portable instrument which is used to measure a number of different temperatures with accuracy. "Checking" may mean many different procedures but in your case it would mean that an experienced man would insert a high-grade temperature-measuring device alongside of every thermometer and thermocouple in your plant to check its accuracy at that particular temperature and in that particular set of installation conditions. If its accuracy is "satisfactory" (depending on the process, etc.—you are the judge), nothing else need be done until the next visit of the service man. If its accuracy is "unsatisfactory," well, it would take many pages to describe how to locate the sources of trouble, how to decide whether they are remediable or whether the instrument should be scrapped, etc.

Standard Instruments. In the foregoing paragraph we mentioned the use of "high-grade temperature-measuring devices" by an outside expert to check your installed thermometers and pyrometers. If you have more than twenty thermometers and thermoelectric pyrometers the purchase of Plant Standard instruments would prove a wise investment. These Plant Standards could be (1) a mercurial thermometer, (2) a resistance thermometer outfit and (3) a thermoelectric pyrometer—I cannot make any recommendation without knowing many details. Or they might consist of *one* portable potentiometer with accessories (one versatile instrument designed for use with resistance primary elements as well as with thermocouples), together with an assortment of resistance "bulbs" and of thermocouples.

With such Plant Standards, the value of your working instruments would be greatly enhanced and you would save money in many ways: fewer rejects, better uniformity of products, etc.

It goes without saying that the correct use of Plant Standards requires some knowledge. The *essential* knowledge can be acquired easily from the instrument manufacturers' instruction booklets and from readily-available handbooks. No *special* skill is required for the routine use of modern high-grade temperature-measuring instruments. Experience is not necessary for routine work but whatever man is assigned to this job will eventually acquire experience of great value in solving unusual problems and in handling unforeseen situations.

Electrical Instruments. You do not mention the type or types of instruments which translate thermocouple emf's into temperature indications or records. I don't know whether they are simple direct-connected portable minia-

Instrument Prices

IN our April editorial we refuted the War Assets advertising assertion that instruments are "expensive." One reader wrote that some instruments (not named) are priced "much too high" and that a magazine serving instrument buyers should crusade for price reductions.

If we did so, fewer instruments would be bought, fewer made. Without opportunity for quantity-production methods and with skilled craftsmen receiving (well-deserved) raises, prices would go up. Moral: to bring down prices, buy more.

That's not the whole story. Our critic may have been startled to discover enormous *price ranges.* The best explanation is to cite once more "The Two Ammeters": one for automobiles; the other a laboratory Standard priced one thousand times as much . . . because it costs 1000 times as much to make. So when you learn that one instrument is priced only twice as much as another of the same category, remember this factor of one thousand.

Another "1000" to remember is that a thousand instrument manufacturers compete for your orders.

NOW is the time to make final plans to attend he ISA's Second National "Instrumentation for Tomorrow" Conference and Exhibit, to be held in the Stevens Hotel, Chicago, Monday to Friday, September 8-12. Every *Instruments* reader who can come should do so, for it will benefit him—AND HIS FIRM. (Yes, an even larger number should attend on company expense than did last year—executives as well as technical employees.)

All technical sessions will be outstanding. All prominent instrument firms will exhibit their new post-war devices. All signs point to a memorable occasion.

ture millivoltmeters, or switchboard millivoltmeters with multiple switches, or elaborate switchboard recorders of the self-balancing type with automatic standardization, automatic switching and identification of the multiple records. Whatever they are, their care is just as important as that of the thermocouple assemblies. From your inquiry I suppose that you do not have any recorders. An excellent investment for you to make immediately is Spencer's "Maintenance and Servicing of Electrical Instruments." The two-dollar price of this unique book is less than the usual minimum price of a service man's call.

Our March 1947 editorial, "On Starting an Instrument Department," may contain other helpful hints.

Cordially yours,

M. F. BEHAR, *Editor*

Airline Pilots Train With New Instruments

A GUEST EDITORIAL

By E. A. POST, Superintendent of Navigational Aids, United Air Lines

TO fully utilize the latest type instruments developed during and since the war for aircraft operations in flight and on the ground, the nation's airlines are carrying on extensive training to acquaint personnel with the new devices and the simplified procedures required for their effective operation.

Such training programs reflect the coördinated effort taking place in the aviation industry in the development of new instruments, new methods and improvements in established procedures. It's all a part of air transportation's progress in making available greater speed, comfort and operating efficiency to the nation's air travelers.

In many cases the airlines are taking advantage of instruments developed by the Army and Navy and first used during the war. In other cases, entirely new instruments have come out of the constant research within established agencies such as ARINC (Aeronautical Radio, Inc.), ANTC (Air Navigation and Traffic Control Group of the Air Transport Association), and RTCA (Radio Technical Commission for Aeronautics).

Training of personnel in the use of new facilities might be termed the end product in their technical development before actual use, but airlines operations men consider this phase as important as the design of the instrument itself. Without full knowledge of how best to use a new device, the basic purpose of such a device is sometimes lost.

United Air Lines, holder of many "flying firsts" and long a leader in the improvement of existing facilities, is currently conducting an ambitious flight training program designed to prepare its pilots to use automatic instrument approach procedures in scheduled operations. The company has been equipping all its four-engined Mainliners with new-type instrument landing devices, plus automatic approach facilities. United's Mainliner 230's (C-54's) for example, have the new Sperry A-12; its Mainliner 300's (Douglas DC-6's) are equipped with Eclipse-Pioneer PB-10 automatic pilot. Such equipment, combined with automatic flight path computer, is recognized as a major development in conquering the problem of maintaining flight schedules regardless of weather and at the same time reducing the cockpit load.

Before such devices can be adopted for commercial operations, however, all United's flight captains are being checked out in the use of automatic instrument approach equipment and procedures.

To do this most effectively and economically—and in a shorter time—United has installed automatic radio navigation units on its fleet of Link trainers. Used in conjunction with flight training, these ground units provide the company's flight personnel with fundamental instruction in all phases of instrument flying.

IF a picture is worth ten thousand words, we really have two guest editorials—one on the cover. Jim Tally's showing of the latest training recorder to United's flight managers deserves close "reading" . . . and you will "read" it closely after you have read what Eddie Post has written especially for you.

—MFB

The new Link units manufactured by Curtiss-Wright are designed to:

1. Provide automatically all navigational signals and indications previously supplied manually by the Link operators.

2. Provide ILS localizer, glide path and marker indications automatically, and

3. Record on a circular chart the track, or "flight path," traversed by the Link trainer in its simulated flight.

By use of the new training equipment, any desired problem can be set up to simulate flight over existing navigational facilities. For instance, the initial approach can be made on the regular aural range with holding procedures being performed, utilizing a fan marker, a compass locator, or both, and then making final approach to the field utilizing the localizer, glide path and marker indications normally associated with the ILS system. In the meantime, the automatic direction finder indicator may be used to show the position of a range station or compass locator. As in the periodic instrument checks, the manual direction finder feature of the unit may be used for taking aural-null bearings and performing aural-null navigational problems.

Even wind—up to 120 mph. and from any direction—can be introduced into the problem to make it wholly realistic.

The Link's flight track is recorded on a 15" circular chart. An interphone system is used for communication between the Link pilot and instructor to simulate radio contacts between planes and ground stations. (See photograph.)

In addition to extensive experience in the new-type Links, United's pilots must accumulate additional hours of training in planes equipped with new-type electronic automatic pilots incorporating automatic approach controls, making numerous manual instrument approaches to 50-foot altitude. To top off their training, they must make a number of fully automatic instrument approaches "under the hood." The pilots must then pass an examination on automatic instrument approach equipment and procedures.

The new Curtiss-Wright Link units not only provide automatically the signals for present navigation and traffic control systems, but can be readily modified to fit in with such new elements as the omni-directional range, distance-measuring equipment, multiple-track computers and other devices.

The story of the development of some of these new airline aids provides a good picture of the coöperative effort which characterizes today's instrument program. Most activity consists in: (1) Testing and evaluating new instruments and procedures; (2) improving the design of present instruments, and (3) planning for the future.

For years, United Air Lines operated a flight research plane, or flying laboratory, in which new developments were tested under actual airline operating conditions. With this plane, United carried on pioneering work looking toward the standardization of instrument landing systems and collaborated in developing the terrain clearance indicator, or radar (absolute) altimeter.

Today, the airlines are not required to do so much research and development. United, for instance, could not hope to accumulate the background of information collected through Army and Navy research during the war. Governmental, manufacturing and operating groups such as the ATA, RTCA, ANTC and ARINC, all well-staffed, provide the means for coördination on an industry-wide basis in order to obtain necessary standardization. However, owing to the number and complexity of the problems, the airlines still contribute substantially to the overall research and development.

Furthermore, the airlines' operating experience still determines the basic requirements. Take the case of the cross pointer-instrument for ILS. This compact mechanism, which indicates an incoming plane's position in relation to the glide path and localizer radio beams, was first developed by governmental agencies. In actual flight operations, however, the airlines found that

(Continued on page 640)

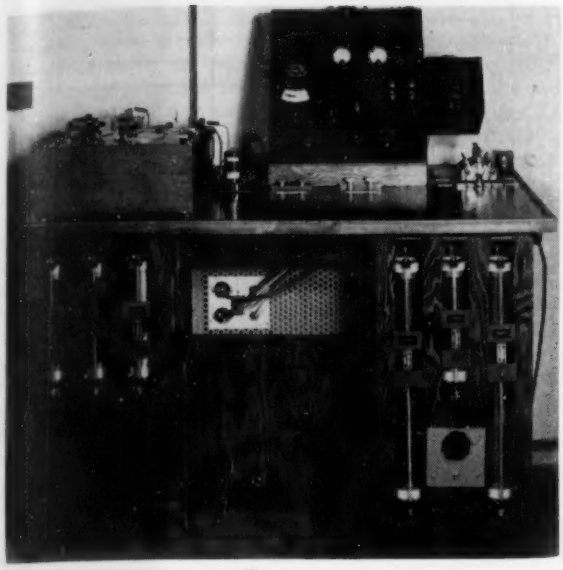


Fig. 1

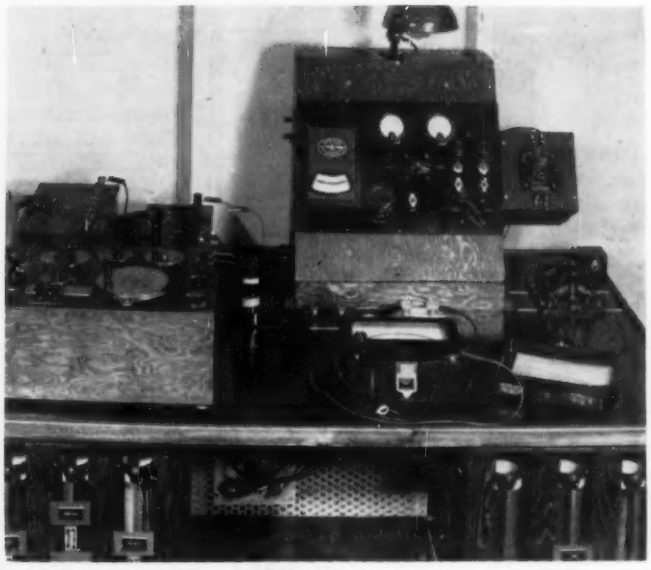


Fig. 2

A Transportable Potentiometer Test Table for Instrument Calibration

By WILLIAM A. CASTNER, Instrument Engineer, Measurements Corporation, Boonton, N. J.

IN industrial plants, the standardization and calibration of electrical indicating instruments is ordinarily considered a job for the standardization laboratory of the instrument manufacturer, or for a well-equipped commercial testing laboratory. The complications involved in setting up a potentiometer and auxiliary equipment for instrument calibration have always been formidably technical and time-consuming.

A transportable potentiometer test table has been designed that is accurate and convenient to use. Circuits are set up for instrument standardization by the simple procedure of throwing a few switches. The only external power required to operate the potentiometer and to activate the instrument undergoing standardization is a 110-volt 60-cycle power line. The over-all accuracy for measuring any electrical function: volts, millivolts, amperes, milliamperes, watts and ohms, is to 5 parts in 10,000 or better. The range of voltage that can be applied and measured is from 100 microvolts to 1200 volts. Current can be measured from 10 microamperes to 10 amperes. By the volt-ampere method any value of resistance can be determined from 100 microhms to 10,000 megohms. Any wattmeter can be standardized whose range in volts × amperes is within the range of the test table.

In a circuit involving the potentiometer principle, a known fractional part of some steady supply voltage is balanced against an unknown emf. with a view to determining the value of the latter. This method of measuring voltage (the Poggendorf method) is the fundamental principle of the potentiometer. The circuit and operation of the simple potentiometer is discussed in most engineering textbooks and need not be gone into at length here. The potentiometer permits direct voltages to be measured with a high degree of precision, by means of a standard cell as the known emf. Essentially, the potentiometer is a high-precision indirect-reading voltmeter of infinite impedance.

Figs. 1, 2, and 3 are three views of the test table; Fig. 4 is the complete wiring diagram in a combination of pictorial and schematic.

Fig. 3

The d-c. power source for applying the potential to activate the instruments under standardization is an a-c. rectifier employing mercury vapor diode tubes, the output of which is electronically regulated.

The power source consists of two separate power supplies. One can supply d-c. power from 0 to 250 volts at 500 milliamperes; the other from 250 to 1200 volts up to 100 milliamperes current drain.

These power supplies are mounted under the test table, one on top of the other, as can be seen in Fig. 1. All connections from the power supply to the control panel are by means of cables and connectors so that the power supplies may easily be removed for servicing and tube replacement, if necessary.

The source of the steady supply voltage that is standardized against the standerd cell is three Edison primary

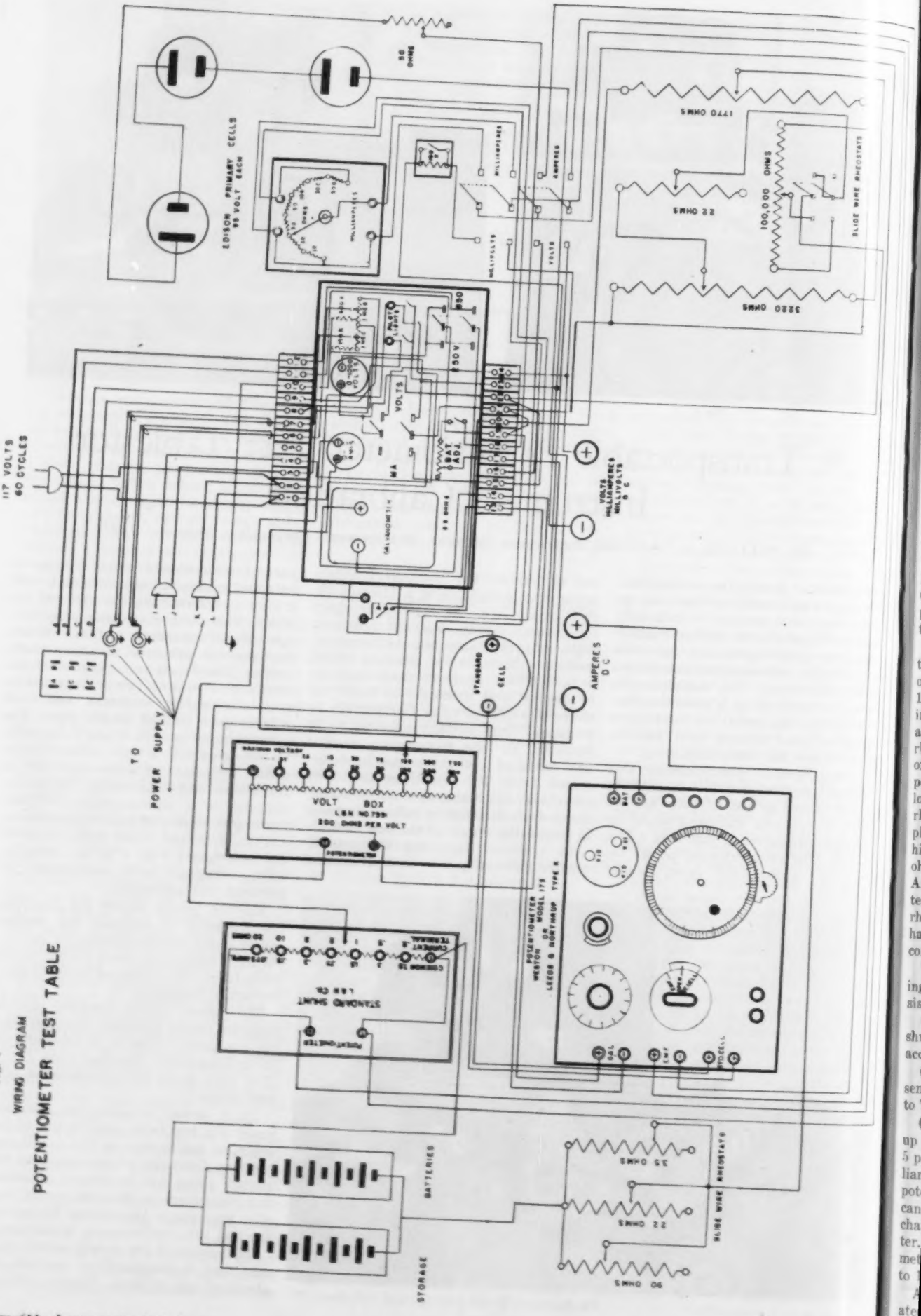


FIG. 4
WIRING DIAGRAM
POTENTIOMETER TEST TABLE

cells of about 0.95 volts each, connected in series with a current-regulating rheostat mounted on the control panel. The primary cells are mounted on the lower deck of the test table in the rear right corner. Edison primary cells are ideally suited for this application by reason of their long shelf life and good stand-by service. No charging is necessary and the elements should only need replacement after several years of moderate service.

For calibrating ammeters of a range greater than 100 milliamperes the current source is storage batteries set in the lower left of the test table. The slide-wire rheostats mounted on the left of the test table are in a series-parallel combination with the storage cells to regulate the value of the current.

The standard cell, the source of known emf. used in this test table, is the Weston unsaturated type of cadmium cell, with an average electromotive force of 1.01865 volts.

The potentiometer is a Weston Model 175, with a range of 1.6 volts. When the actual emf. being measured by the potentiometer is greater than 0.001 volts, the accuracy of this potentiometer should exceed 1 part in 10,000. When the emf. to be determined is near 1.0 volt the accuracy is 1 part in 100,000. A Leeds & Northrup Type K-2 potentiometer can be substituted in the test table without any circuit changes.

The slide-wire rheostat cabinet on the right front of the test table consists of three slide-wire rheostats, of 3220, 1770 and 22 ohms. These rheostats are in a series-parallel arrangement with a 100,000-ohm General Radio rotary rheostat that can be switched in or out of the attenuation network by a double-pole double-throw switch mounted below the rheostat knob. The 100,000-ohm rheostat is to be able to reduce the applied voltage to very small values. For higher values of voltage the 100,000-ohm rheostat is taken out of the circuit. An I-shaped piece of Bakelite is fastened to the sliding member of each rheostat as a guard to prevent the hands of the operator from coming in contact with any part of the rheostat.

The auxiliary equipment for extending the range of the potentiometer consists of:

(1) A Leeds & Northrup standard shunt, range from 0.075 to 7.5 amperes, accuracy 4 parts in 10,000;

(2) A Leeds & Northrup volt box, sensitivity 200 ohms per volt, range 3 to 750 volts, accuracy 4 parts in 10,000;

(3) A milliampere shunt box made up from precision resistors (accuracy 5 parts in 10,000), range 10 to 100 milliamperes for 1.0 volt drop across the potentiometer. Its calibrating range can be reduced 10 to 1 and 100 to 1 by changing the range of the potentiometer. It can be used to calibrate milliammeters of ranges from 10 microamperes to 100 milliamperes.

All switches and controls are situated on the table top or the control panel to be readily accessible. On the table top to the right of the operator are two double-pole double-throw knife-blade switches. The four possible positions of these switches are identified with labels of the four electrical functions: volts, amperes, milliamperes and millivolts. In the center of the test table are two sets of binding posts, labeled to indicate that connections are to be made for voltmeters, milliammeters, and millivoltmeters to one, and ammeters to the others. The galvanometer and the control knob of the rheostat for adjusting the standardizing current of the potentiometer are on the left of the control panel immediately in front of the operator. In the center of the control panel is a d-c. voltmeter, 0-1000 volts, and a d-c. ammeter, 0-10 amperes, for control purposes. They indicate the potential appearing at the potential binding post and the current flowing from the ampere binding post to prevent excessive overloads being applied unknowingly to instruments set up for calibration.

The power supplies are so designed that when the power cord from the back of the test table is plugged into a 110-volt 60-cycle line all the filaments of the tubes are on. The two switches on the control panel apply the plate voltage to the rectifier tubes of the power supply selected. This is done this way to prevent plate voltage from being applied to the mercury vapor diode tubes before the filaments are warm. (If this were not done the life of the tubes would be impaired.)

There is a plate voltage switch, neon pilot light and control knob for each power supply on the right of the control panel. These are arranged in a vertical parallel line. At the lower right of the control panel is a rotary type double-pole double-throw switch for selecting the proper power supply. The position of the switch is labeled to indicate which of the two sets of controls is connected to the attenuator network for application to an instrument at the binding post.

The control knobs on the right of the panel associated with the power supplies are feedback controls to the grid of a 6SN7 tube of the electronic regulator section of their respective power supply. This gives a voltage control of the upper third of the output of each supply. To the left of the control panel on the side of the control panel box is a small panel with two binding posts and a switch. When this switch is in the ON position, connection is made directly to the output of the high voltage power supply, and the attenuator network is disconnected. This is done for voltages in excess of 800 volts. There is some current drain in the attenuator system when it is connected, and it prevents the power supply from delivering its maximum output. These binding posts were purposely placed near the volt box so that when calibrating a high-range voltmeter, the range of the volt box can be extended by an auxiliary volt box having the same sensitivity of 200 ohms per volt. Connections can be safely and readily made.

Procedures

Let us assume that it is desired to make a calibration check and provide a calibration curve for a milliammeter with a range of 10 milliamperes, used as a standard in an inspection department. The power line cord is plugged into a 110-volt 60-cycle power line and, after a few minutes to warm up the filaments of the mercury vapor rectifier tubes, the plate voltage switch of the low-voltage power supply is turned on. Next, the potentiometer is standardized against the standard cell by adjusting the current from the Edison primary cells. The control for this operation is on the left of the control panel as previously described. The switch on the milliampere shunt box is set to 10 milliamperes and the potentiometer is set to measure 1.0 volt. One of the d-p.d-t. switches is thrown as labeled to the milliampere position. The instrument to be standardized is now connected to the right-hand set of binding posts, and the attenuating slide-wire rheostats are adjusted until the potentiometer is at null balance. A current of 10 milliamperes is now flowing through the milliammeter. The reading can be noted and the correction can be tabulated. Readings on down the scale of the milliammeter can be read by bringing the potentiometer to balance, measuring voltage in the proportion of 1.0 volt to 10 milliamperes.

The procedure for calibrating or standardizing voltmeters or ammeters is similar. The d-p.d-t. function switches are thrown to the function desired and the proper range selected on the volt box or the ampere shunt box.

To demonstrate the versatility of this test table, let it be required to determine the resistance of a resistor whose value is suspected to be of the order of 10 megohms. Connect the resistor across the right-hand binding post and then, by throwing the proper function switch to volts, measure and apply 1000 volts. Then do not change the attenuator setting, but change the functional switch to measure the current flowing through the resistor, which should be of the order of 100 microamperes. By Ohm's Law, the exact value of the resistor can be calculated to within 0.1%.

Wattmeters can be calibrated by connecting the potential coils of the wattmeter to the voltage binding post, and the current or field coils to the current binding post, then, alternately measuring the current and potential applied, the wattmeter will indicate the product of volts and amperes or watts.

This test table is not available commercially, but most of the electrical components are readily obtainable on the market and, moreover, the writer is authorized to state that Measurements Corporation welcomes inquiries from interested persons.

Testing Precision Timing Instruments

By G. WILEY, 17 Van Reypen St., Jersey City 6, N. J.
(Chief Horologist, A. R. & J. E. Meylan, New York City.)

INDUSTRY today is becoming increasingly conscious and appreciative of the innumerable duties technical watches perform. Although such watches were being manufactured decades ago, their widespread applications to industry could not be foreseen then. Technical watches as we know them today differ greatly from the old so-called sport watches. These were used almost exclusively in timing sporting events. The performances of those pioneer timing instruments left much to be desired. Had there not been many improvements, industry today would not seek the services of timing instruments so extensively.

However, it must not be taken for granted that all watches one sees so elaborately advertised as technical watches are truly technical in the sense that they meet the requirements of technical men; far from it!

Unfortunately for the buyer, the quality is a concealed element. Nicely polished nickel-plated organs, rubies well in sight, might please the eye of the buyer but may hide materials of poor quality or serious defects in construction. Even if the occasion were given the layman to scrutinize the interior of a complicated timing instrument such as a split-second timer or a chronograph,* everything would appear so complicated that it would be impossible for him to differentiate between the superior and the inferior specimens. Choosing the proper type of precision timing instrument best suited to one's needs with regard to performances and accuracy is a matter of serious consideration and great importance. Before purchasing a timepiece or having a valuable timing instrument repaired, it is advisable to consult a technical watch specialist who will give detailed information and authoritative advice regarding the performances of watches and other timepieces.

Precision is the criterion of all timing instruments. A precision timing instrument must perform according to rigorous specifications. In making tests warranting great exactitude, an engineer would not chance to use an inferior or badly-adjusted timepiece any more than a pharmacist would risk poisoning his customers by using an inferior scale in concocting his prescriptions. Length, mass and time must be measured correctly if at all.

Standards of performances have been established for a wide variety of technical watches for the certification of their dependability and accuracy. It is problematical how many wrist chronographs on the market today could perform within the tolerances listed in the following Program and Criteria. They were suggested by the National Bureau of Standards, Washington, in response to the report of a test program which was sent for consultation and review.

Program of Test

Period 1. 4 days in the dial-up (DU) position with the sweep hand not running.

Period 2. 4 days in the crown-down (CD) position with the sweep hand not running.

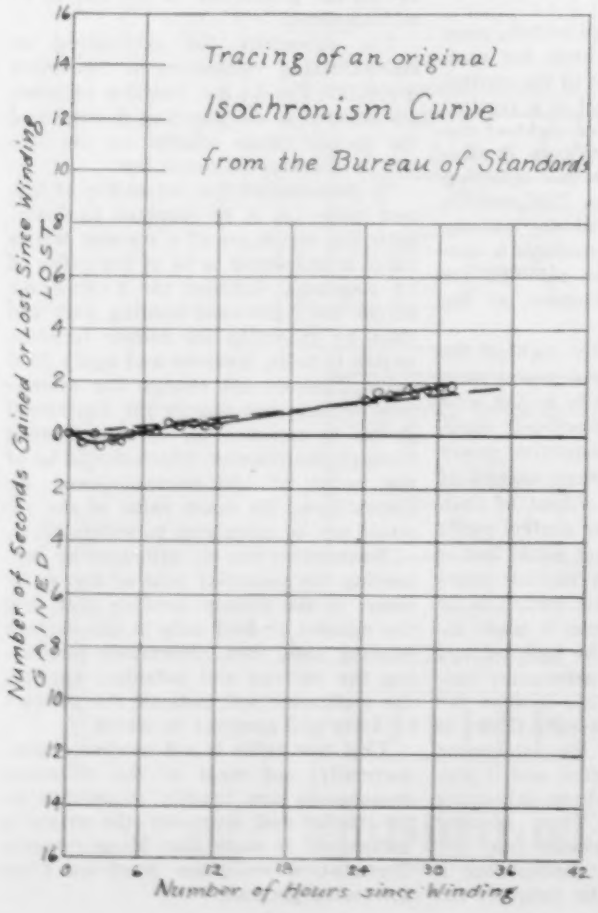
Period 3. 1 day in the dial-up (DU) position with sweep hand not running.

Period 4. 4 days in the dial-up (DU) position with the sweep hand running.

Period 5. 4 days in the crown-down (CD) position with the sweep hand running.

Period 6. 4 runs of one hour each, including the starting, stopping and flyback of the sweep hand.

*The generic term chronograph is used throughout this article instead of the formal term chronoscope. The term chronograph which we wrongly utilize to designate certain chronometric instruments is a Greek etymology. It is formed of two roots, "chrono" meaning time and "grapho" meaning to write. The correct term should be chronoscope, using the Greek "skopeo" which signifies "I examine."



1063-1

DEPARTMENT OF COMMERCE

Bureau of Standards

REPORT

on a

Agassiz

17 Jewel

Watch

No. 244524

Submitted by

Gaston Wiley

Jersey City, N. J.

The watch described above was submitted to the Class A test described on the following pages with the results given on the attached "Abstract of Results." Its performance failed to meet the requirements for a certificate of Class A for the following reasons

It exceeded the tolerance for criterion 9.

Lyman J. Briggs, Director

Test Completed, Oct. 20, 1944
Test No 103032

Washington, D. C.

Second page of National Bureau of Standards report.

CRITERIA

	Tolerance seconds
1. Mean correction for 24 hours in each position (use whichever is the larger). Periods 1 and 2).	±12
2. Maximum correction for 24 hours in either position. (Periods 1 and 2).	±15
3. Maximum difference in any two corrections in the same position. (Periods 1 and 2).	5
4. Difference in the mean corrections in the two positions. (Periods 1 and 2).	10
5. Recovery in the dial-up position. (Periods 1 and 3).	7
6. Maximum difference in the mean corrections in the same position with the sweep hand running and not running. (Periods 1 and 4, and Periods 2 and 5).	10
7. Mean correction for 1 hour when used as a stop watch. (Period 6).	±1.5

Other test programs varying in severity and graded according to classification have been devised for practically every kind of precision timing instrument. It can therefore be construed that adherence to established standards is a valid manner to determine the worthiness of precision timing instruments.

DETAILED DESCRIPTION AND DISCUSSION OF WRIST CHRONOGRAPH TEST

1. *Mean Correction for 24 Hours in Each Position.*

This is computed for Periods 1 and 2 in which the sweep hand is not running. The mean correction for each period is found by taking the algebraic mean of the four corrections in each period. Neither of these means should exceed the tolerance for this criterion. Suggested tolerance, 12 seconds.

2. *Maximum Correction for 24 Hours in Either Position.*

This is computed for periods 1 and 2 in which the sweep hand is not running. The largest correction for any of the eight days comprising these two periods should not exceed the tolerance for this criterion. This suggested tolerance is 15 seconds.

3. *Maximum Difference in Any Two Corrections in the Same Position.*

This applies only to Periods 1 and 2. The largest algebraic difference in any two of the corrections in Period 1 or of any two of the corrections in Period 2 should not exceed the tolerance for this criterion. The suggested tolerance is 5 seconds. (This criterion shows the "repeatability" in performance for 24 hours under similar conditions.)

4. *Difference in the Mean Corrections for the Two Positions.*

This is computed as the algebraic difference between the mean correction in Period 1 and the mean correction in Period 2. This difference should not exceed the tolerance for this criterion. The suggested tolerance is 10 seconds. (This criterion shows the effect of change of position on the performance of the watch.)

5. *Recovery in the Dial-up Position.*

This is computed by taking the algebraic difference between the correction obtained in Period 3 and the mean of the corrections obtained in Period 1, both periods being with the watch in the same position. This difference should not exceed the tolerance for this criterion. The suggested tolerance is 7 seconds. (This criterion shows how well the watch recovers, under similar conditions, after a change of position.)

6. *Maximum Difference in Corrections in the Same Position with the Sweep Hand Running and Not Running.*

This is found from Periods 1 and 4 (DU) and Periods 2 and 5 (CR) by taking the difference in the mean corrections for the two periods in the same position. Neither of these differences should exceed the tolerance for this criterion. The suggested tolerance is 10 seconds. (This criterion shows the effect of the running of the sweep hand on the performance of the watch.)

7. *Mean Correction for 1 Hour when Used as a Stop Watch.*

This is the algebraic mean of the four corrections found in period 6, and should not exceed the tolerance for this criterion. The suggested tolerance is 1.5 seconds. (This criterion shows the performance as a stop watch over a short period in which the sweep hand is started from zero, stopped, and returned to zero by operation of the push piece on the watch.)

This particular wrist chronograph test was designed primarily for proving or disproving, to my own satisfaction, the validity of accuracy claims made for this particular type of timepiece.

Another object of the test was to provide a basis or a ranging point for our repairers engaged in the precision timing of wrist chronographs.

The original test report as sent to the National Bureau of Standards follows.

[EDITOR'S NOTE. — There followed four sheets full of test-log entries by the author and his assistants as sent *TO* the Bureau and also a complete test report *FROM* the Bureau to the author. This material would fill several pages of *Instruments*. Instead, we have made four illustrations from which our readers will obtain an excellent general impression.—M. F. BEHAR.]

1063-1

ABSTRACT OF RESULTS

OF THE TEST UNDER CLASS A

OF Agassiz, 17-Jewel WATCH

Number 244524

Rated at the Bureau of Standards

from Aug. 21, to Oct. 20, 1948

OBSERVED RATES.

POSITION	Period Number	Temperature C	Temperature F	Rate Sec.	Period Number	Temperature C	Temperature F	Rate Sec.	MEAN RATE Sec.
Vertical, Pendant Up	1	27.9		-0.40	10	26.2		+3.73	+1.66
Vertical, Pendant Right	2	27.1		+3.80	9	26.0		+2.93	+3.36
Vertical, Pendant Left	3	25.8		-0.93	8	25.4		+1.13	+0.10
Horizontal, Dial Up	4	26.4		+0.67	7	25.9		+1.43	+1.05
Horizontal, Dial Down	5	25.4		+1.17	6	25.1		+1.53	+1.35
Horizontal, Dial Up	12	2.8		+7.28					
Horizontal, Dial Up	13	21.5		+1.20					
Horizontal, Dial Up	14	34.9		-0.28					
Vertical, Pendant Up	15	26.2		+4.00					

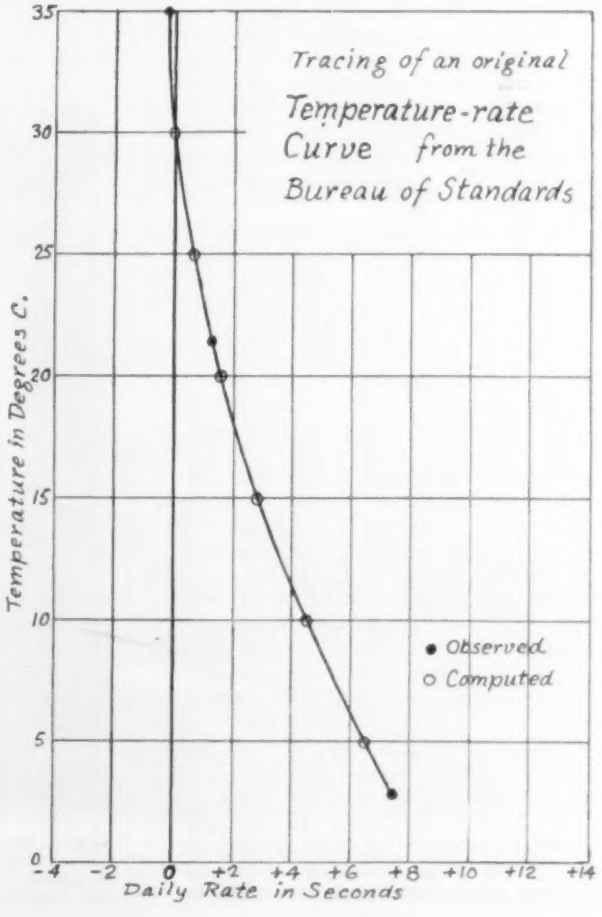
A Plus (+) Rate = Losing.
A Minus (-) Rate = Gaining.

DERIVED RESULTS.

CRITERIA.	Actual Amount Sec.	Tolerance Allowed Sec.
1. Mean Deviation of Daily Rate	0.10	± 0.75
2. Mean Deviation of Rate for Change of Position	0.80	± 3.00
3. Largest Difference of Rates of Any Two Positions	3.26	± 10.0
4. Rate in Horizontal, Dial Up minus Vertical, Pendant Up Position	-0.61	± 5.0
5. Rate in Horizontal, Dial Down minus Horizontal, Dial Up Position	+0.30	± 4.0
6. Progressive Change in Rate in Periods 1 to 10	0.36	± 3.00
7. Recovery of Rate, Period 15 minus Period 1	+4.40	± 6.0
8. Isochronism Error (see curve)	0.5	± 3.0
9. Difference of Rate per 1° C from 5° to 35° C	-0.22	± 0.20 *
Difference of Rate per 1° C from 5° to 20° C	-0.32	
Difference of Rate per 1° C from 20° to 35° C	-0.12	
10. Difference of Rate per 1° C from 5° to 20° C minus Difference of Rate per 1° C from 5° to 35° C	-0.10	± 0.30
11. Largest Mean Daily Rate of Any Period (Period 12)	+7.28	± 10.0

* exceeded tolerance

Last page of National Bureau of Standards report.



Crystal Clock for Accurate Time Signals

By VINCENT E. HEATON, National Bureau of Standards, Washington, D. C.

DEMAND for time interval signals accurate to a microsecond in navigation, seismology, and geological surveys, led to the development of the crystal clock, utilizing electronic circuits instead of conventional clock mechanisms. Developed by the National Bureau of Standards, the crystal clock is now broadcasting one-second time pulses throughout the world—the only continuous time signal service provided by any country. One or more of the frequencies broadcast continuously (5, 10, and 15 megacycles per second and 2.5 Mc. at night) may be received on the usual short-wave radio receiver. These highly-accurate time signals, which proved of great assistance to the Armed Forces in World War II, are now providing an expanding peacetime service to industry, scientific laboratories, and schools.

The heart of the Bureau's crystal clocks consists of a flawless crystal of quartz with series resonance frequency of approximately 100,000 or 200,000 cycles per second. By electron-tube circuits the crystal is continuously oscillated and the resulting frequency is divided with no loss of accuracy to 60 cycles per second. This 60-cycle frequency supplies power to a synchronous motor which, through gear trains, drives contacts that give intervals of one minute, five minutes, and thirty minutes to control the automatic announcement equipment of the transmitters. The motor also operates a one-second contact which opens an electrical gate and allows a highly accurate seconds pulse to be broadcast.

The accuracy of the seconds pulse does not depend on the closing time of the contact. The accuracy is determined by the crystal oscillator frequency which controls a square-wave generator and the adjustment of this generator which supplies voltage to an amplifier during alternate 1/200th second intervals. A standard 1000-cycle frequency is fed into the amplifier so that the output consists of groups of five cycles of 1000-cycle frequency spaced 1/200th second apart. During the time when no signal is being passed by the amplifier, the seconds contact is closed and it is opened during the next no signal period. Therefore, the seconds pulse consists of five cycles of 1000-cycle frequency given once each second, supplying a seconds pulse 1/200th second long.

The absolute accuracy of the frequency of the crystal oscillator is at present within a few parts in one hundred million. Although the seconds pulses are obtained by exact division of the quartz plate frequency, owing to possible phase shifts and other difficulties, the pulses are accurate to one part in one million. In other words, the length of a one-second interval as broadcast is accurate to one microsecond. An interval of one minute or larger is accurate to a few parts in one hundred million.

However, to supply an accurate time interval is one thing; to supply a time signal with a high absolute accuracy is quite another. The Bureau depends upon the Naval Observatory to supply the absolute time and differences between this and the time signals broadcast from the Bureau's radio station WWV at Beltsville, Maryland. As these differences are based upon data obtained both before and after radio time signal has been transmitted, it is necessary to extrapolate continually the data from a known correct value two or more weeks in the past. For this reason there are days when the error to the absolute value of the broadcast time may be as great as 0.02 second.

The quartz crystal of the clock is cut to a certain size and at an angle to the axis of the mother crystal to give the desired frequency and temperature coefficient. Each clock also has a driver circuit arrangement and frequency-dividing equipment. The rate of the crystal clock depends on the temperature, pressure, and humidity of the air around the quartz plate, and the operating voltage of the circuit supplying the frequency-conditions which call for extremely accurate control. Pressure and humidity are maintained by sealing the quartz plate in a glass or metal enclosure; temperature is held constant by placing the quartz plate and certain important parts of the circuit arrangement in a constant-temperature oven.

There are certain similarities and differences in the crystal clock and the conventional pendulum clock. Each is affected by changes in pressure and temperature; but these conditions may be controlled. The pendulum clock, however, is affected by changes in the gravitational constant to such an extent that changes in water level in the ground, or the tides when the clock is near the seashore, may result in a measurable change in rate. Such changes in gravity produce no noticeable effect on the rate of the crystal clock. It is possible to compare crystal clocks at high frequencies to determine erratic behavior accurately. This has not been done with pendulum clocks.

At the Bureau the equipment used in comparing the various crystal clocks measures accurately in a few seconds a change of rate equivalent to 1 second in 50 years. During one month, the change in the rate of drift of a good crystal clock may be less than +1 part in one hundred million. Therefore if the clock

Fig. 1. Interior view of the NBS 100-kc. standard frequency oscillator which provides the constant frequency controlling the crystal clock. Quartz-crystal unit, in evacuated container, and part of oscillator circuit arrangement, are shown in temperature-controlled compartment. Layers of aluminum and felt are used to obtain uniform temperature.

began the year with correct time and zero rate of drift, it would have gained approximately 2 seconds by the end of the year. The short-time variations (10 minutes or less) are less than one part in one billion.

The broadcasting of time by the National Bureau of Standards came as a by-product of the standard frequency broadcast services which were begun in 1922. Intermittent broadcasts during certain hours of the day became continuous after January 1941, with station identification at five minute intervals. The one-second pulses given as a modulation to the transmitted signal were not announced time signals. However, these pulses did mark time intervals which could be used for the timing of events or for determining the rate of a clock.

Owing to the interest of the military forces, the one-second pulses of the crystal clock were brought into close agreement with the Naval Observatory time signals. In February, 1944, the 59th second pulse was omitted to designate the end of each minute. Announcements of Eastern Standard Time in Continental (International Morse) Code have since been added during the announcement period, which occur each five minutes. These announcements are given during an interruption to the standard audio frequencies which start exactly on the hour.

In addition to the continuous accurate time intervals and announcements, the broadcast by radio station WWV provides standard radio frequencies, standard audio frequencies (440 and 4000 cps.), the standard musical pitch (A above middle C), and radio propagation disturbance warning notices.

Fig. 2. Front view of the NBS Seconds Pulse Generator and Time Interval Selector.

There are many peacetime uses for frequency and time services other than checking the operation of clocks and other time-pieces. The accurate measurement of time is of importance in seismology, geodesy, and navigation, in other countries as well as our own. The broadcasts are being utilized by many organizations such as schools and universities, scientific laboratories, manufacturers, and users of radio communications equipment; observatories which are widely separated and make automatic recordings of astronomical phenomena and motions of earth; power companies which continuously check the frequency of power generated at widely separated stations; communications companies which regularly transmit photographs by wire or radio; and certain radio broadcast companies which synchronize program features from various countries.

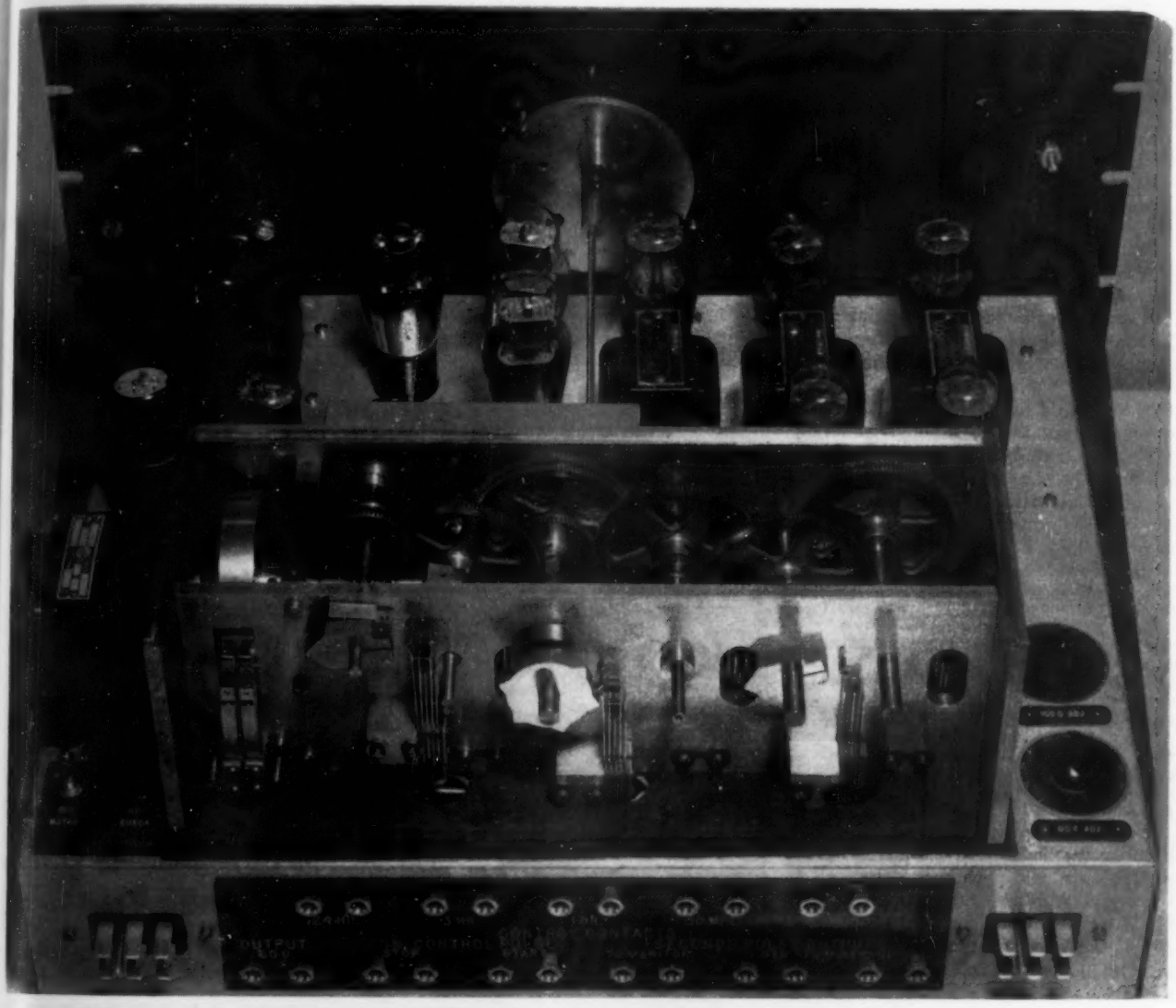


Fig. 3. Rear view of the NBS Seconds Pulse Generator and Time Interval Selector used in the time control equipment of the Bureau's radio station WWV. The one-second contact is made by a cam on the flywheel immediately to the right of the electric motor. The succeeding cams are for the longer time intervals, controlling the announcements for the radio station.

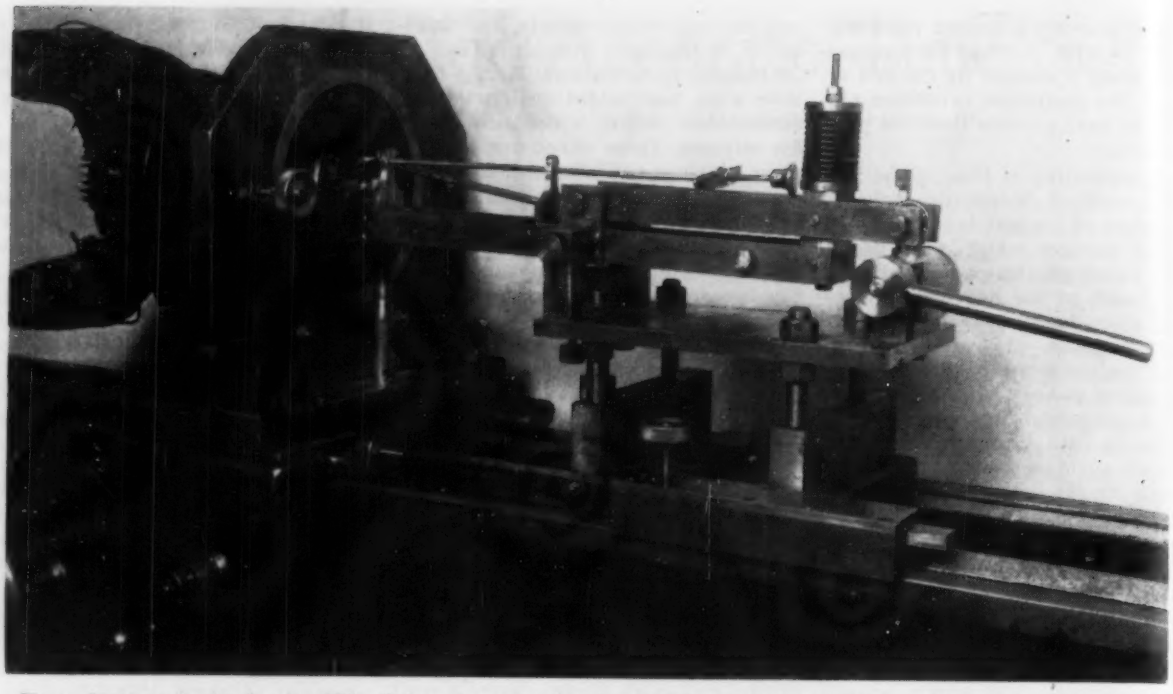


Fig. 1. Apparatus developed at the NBS utilizing a diamond indentation method of measuring extremely small increments of wear. An aircraft engine cylinder is shown mounted in a special fixture with the gage in position to make a mark on the cylinder surface.

A New Method of Measuring Wear of Machinery Surfaces

By F. G. BRICKWEDDE, Chief, Heat and Power Division, National Bureau of Standards, Washington, D. C.

IN determining the wear of machinery surfaces, a major difficulty has been the lack of a convenient method for accurately measuring the amount of material worn off. Among the methods that have been widely used are: (1) weighing parts before and after wear; (2) measuring the dimensions of parts before and after wear; and (3) determining the amount of worn material found in the lubricant after operation. Even under ideal conditions, these methods have serious limitations:

The weighing method gives a value for the total wear but does not indicate where the wear occurred.

Measuring the changes in the dimensions of a worn piece has this same limitation to a lesser dergee and does not differentiate between actual wear and other changes that may occur, such as growth, shrinkage, or distortion of the part.

The method of determining the amount of worn material in the lubricant presents a number of difficulties and ordinarily is used only as a qualitative indication in conjunction with other data.

These limitations—especially the fact that the methods often measured other conditions along with wear—indicated the desirability of a method of measuring wear that would be: (a) independent of the size or mass of the wearing piece; (b) specific, i.e., measuring wear and nothing else; (c) "local," i.e., measuring wear where it occurs and not elsewhere; (d) capable of *detecting* wear increments of the order of a few microinches; (e) capable of *measuring* total wear to an accuracy of a few hundred-thousandths of an inch.

When a scratched surface is purposely abraded in order to smooth it, the scratches disappear — the shallowest ones most quickly, the medium ones later, a few deep ones remaining in some instances. This effect has been known since the dawn of handicrafts

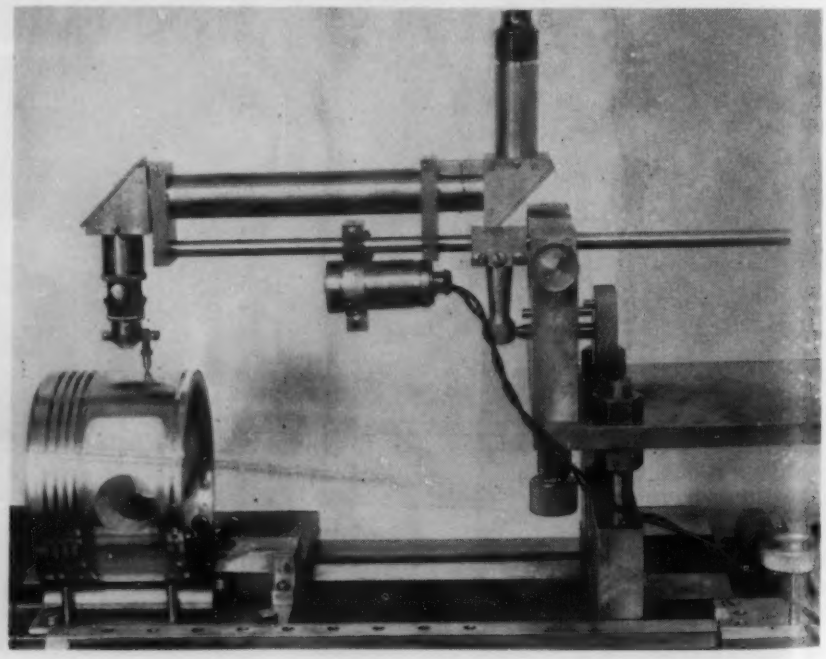


Fig. 2. Viewing and measuring apparatus used in conjunction with the McKee wear gage consists of a microscope and eye-piece scale modified to be used as a periscope for viewing the inside of a cylinder. In this set-up the apparatus is being used to view and measure the changes in dimension of a mark placed on a piston surface.

many centuries ago. But it only gives a qualitative idea of the amount of material removed by polishing operations—because the depths of the scratches were not known.

A practical solution of this problem has been found in the use of a diamond indenter originally developed at the National Bureau of Standards for measuring the surface hardness of glasses, crystals and other hard materials. More than ten years ago Frederick Knoop and other NBS research workers had devised a hardness-testing method based on measuring the length (and hence the depth) of the indentation made under a specified standard load by a tiny diamond point carefully shaped to the form of a four-sided pyramid with rhombus base and obtuse included angles.* Measurements are made by microscope for the sake of accuracy, since the indentation is barely visible.

Investigations conducted at the National Bureau of Standards under S. A. McKee recently led to the adaptation of the diamond indentation method of measuring wear.† As a result a sensitive measuring instrument, the McKee Wear Gage has been developed to measure extremely small increments of wear, as little as one hundred-thousanths of an inch under favorable conditions—considerably less than with other methods.

*Frederick Knoop, U. S. Patent 2,091,995 (Sept. 7, 1937); see also: F. Knoop, C. G. Peters and W. B. Emerson, "A Sensitive Pyramidal Diamond Tool for Indentation Measurements," *Bureau of Standards Journal of Research*, Vol. 23, 1939, pages 29-61.

†Developed at the National Bureau of Standards by S. A. McKee at the suggestion of and with collaboration of Dr. H. C. Dickinson. The method is covered by U. S. Patent No. 2,233,403, granted to Dickinson and McKee and assigned by them to the United States Government.

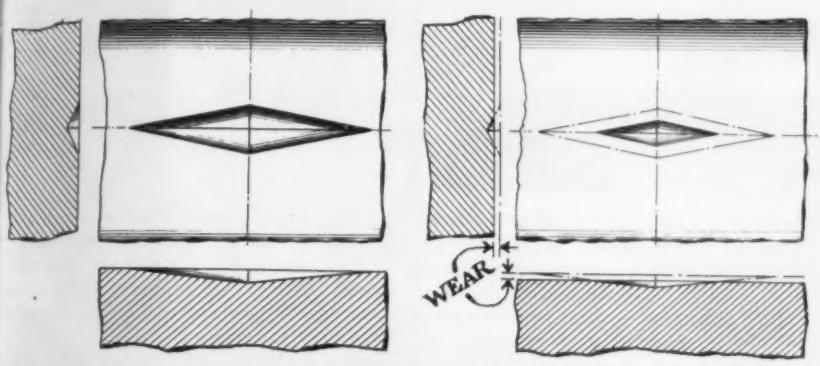


Fig. 3. Enlarged diagrams of a typical indentation made with the McKee wear gage by pressing into the wearing surface the apex of a four-sided diamond pyramid having a rhombus-shaped base. Left: before wear has occurred; right: same mark after material has been worn from the surface. It will be noted that the shape of the mark remains the same, but the length decreases in proportion to the thickness of material removed. For the diamond used, the ratio of depth of mark to length of long axis is about 1 to 35, that is, a mark about 0.001″ deep has a long axis of about 0.035″.

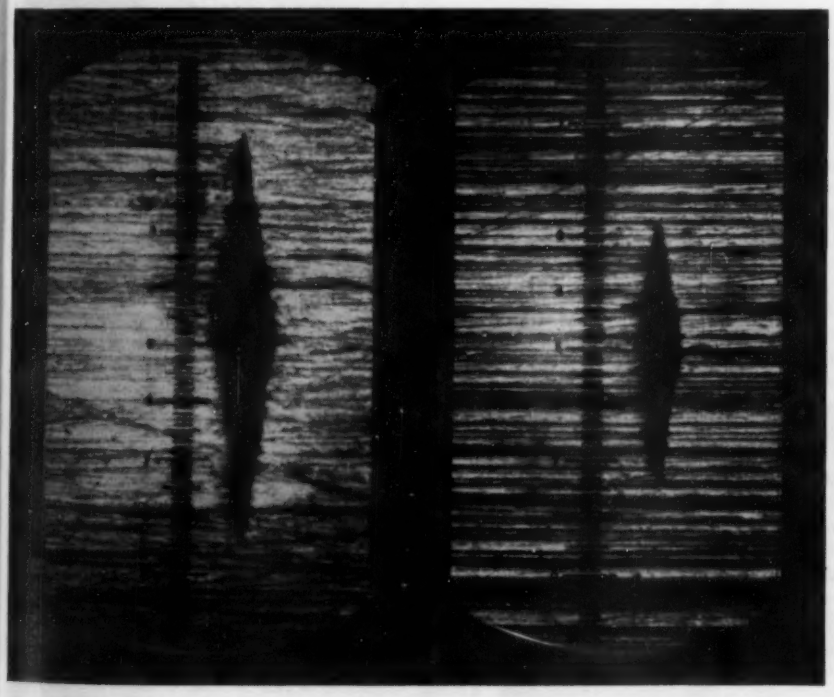


Fig. 4. Photograph (after engine operation) of two typical marks used for determining extremely small increments of cylinder wear by the diamond indentation method developed at the NBS. These marks were originally about 0.9 mm. long. The scales shown represent an actual length of 1 mm. (0.0394″) but when observed in the viewing apparatus are 2½″ long. For the diamond used and chrome-molybdenum steel cylinders the total length of the scale represents about 0.0012″ in depth, hence one of the small scale divisions is equivalent to slightly more than 0.0001″ of wear.

The McKee gage was designed primarily to locate and measure indentation marks on the cylinder walls and pistons of radial aircraft engines, since permanent distortion of such parts during operation had heretofore nullified the significance of any previous methods of measurement.

Special apparatus was developed for making and measuring the marks placed on the wearing surfaces by the diamond indenter of the wear gage. With a cylinder or piston mounted in a specially-designed fixture, marks are applied at any desired position on the surface by means of the diamond point, which is forced by mechanical pressure to a predetermined depth into the surface piece. The viewing and measuring apparatus consists of a conventional microscope and eye-piece, modified by the addition of two right-angle prisms so that it may be used as a periscope for viewing the inside of the cylinders.

The impression of a mark in the surface of the metal raises a burr around the mark. The shape of the diamond indenter is such, however, that the major portion of the burr is formed on the sides of the mark. Though no burr is visible to the eye at the ends of the mark, the presence of a very slight elevation of the surface may account for the minor deviations from a straight line shown by calibration curves. In the course of the investigation it was found that most of the burr could be easily removed by rubbing lightly with fine polishing paper. For use with the cylinders a sheet-metal guard, similar to the usual erasing shield but of larger dimensions, was found convenient. The holes in this guard are so arranged that the polishing paper can be rubbed over a small area at each mark on the cylinder wall with one finger.

As the marks are placed with their long axes perpendicular to the axis of the cylinder, the relation between the change in depth of mark to change in length of long axis is affected by the curvature of the cylinder. While this effect is relatively small for the particular cylinders used, suitable corrections for curvature provide greater accuracy in determining wear.

A study was also made of the possibility of error due to the axis of the diamond indenter not being at right angles to the surface when the indentation is made. Computations indicated that if the diamond-shaped mark was symmetrical to within a ratio of not less than 41 to 50 along its major axis, the error would be no greater than one percent (approximately 0.00001″). It was found that the apparatus could be adjusted to produce a symmetrical mark and that other marks, either in the

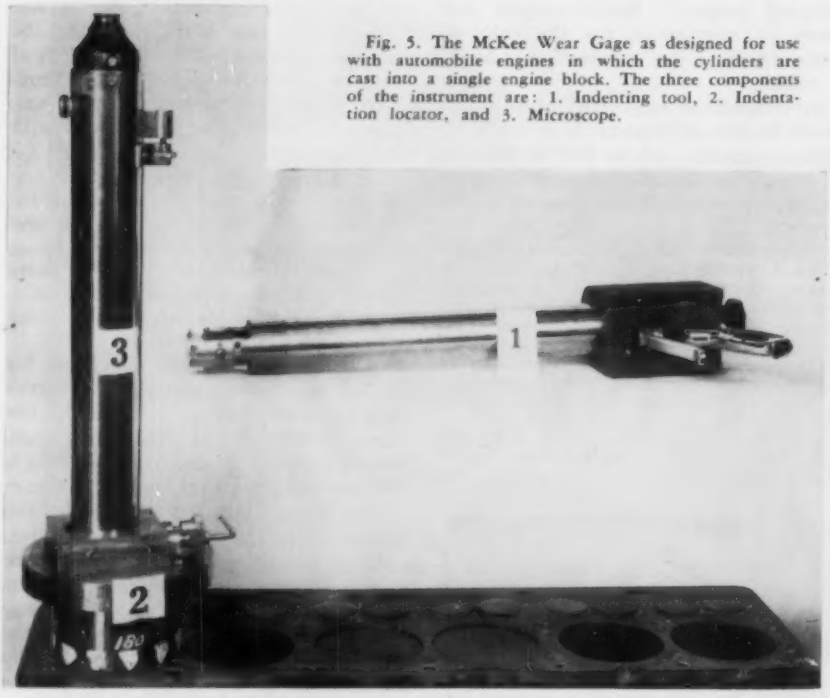


Fig. 5. The McKee Wear Gage as designed for use with automobile engines in which the cylinders are cast into a single engine block. The three components of the instrument are: 1. Indenting tool, 2. Indentation locator, and 3. Microscope.

same cylinder or in other cylinders of the same nominal size, could be made well within the limits of symmetry without further adjustment. Accordingly, corrections for lack of symmetry were not necessary.

One of the important considerations in the Bureau's investigation was uncertainty as to whether the marks would return to their shape during operation of the engine. Results of a number of engine tests have shown that marks in the cylinders of radial aircraft engines retain their shape sufficiently to provide reasonably accurate wear measurements. Experience has indicated that results are not as satisfactory after the marks have been worn to about one-fourth of their original length or less. Hence greater accuracy may be obtained by carefully regulating the size of the mark and adjusting the duration of the test.

The precision of the wear measurements depends upon the condition of the indentation. With new marks the points are sharp and the lengths can be accurately determined. However, after the engine has been operated, the marks are somewhat blunted and it is necessary to estimate the position of the point (Figs. 3 and 4). Under normal conditions the cylinder wear can be determined with an overall accuracy of $\pm 0.000{,}04''$. For more favorable conditions the degree of accuracy can be increased to $\pm 0.000{,}02''$. Operating experience with marks in the pistons indicates that, with the softer aluminum alloy, the marks have a much greater tendency to distort and the results are not entirely satisfactory. Another difficulty with this material is its tendency to become impregnated with carbon making it difficult to distinguish the marks.

Most of the engine tests for determining the performance of the marks in service were made with aircraft engines having chrome-molybdenum steel cylinder barrels $5\frac{3}{16}''$ in diameter. In these tests, twenty-four marks were made in each cylinder, six spaced 60° apart at each of four levels —approximately 2″, 4″, 6″ and 8″ from the open skirt end of the cylinder. The upper row of marks was in contact with the top ring only while the lower was contacted by the oil ring. Typical cylinder wear patterns obtained in these tests reveal unsymmetrical wear with respect to the axis of the cylinder that would be impossible to determine with usual measurements of diameter.

Employing the basic principles of the original McKee gage, an instrument was designed by the American Instrument Company for use with automobile engines in which the cylinders are cast into a single engine block. This instrument, used in an extensive series of tests by C. S. Bruce, J. T. Duck and A. R. Pierce of the Bureau's Automotive Section, permitted accurate studies of the effects of wear in stock passenger-car engines operated under controlled conditions. The test engines were operated for 144 hours (approximately 3000 miles of normal operation) between wear measurements, the operating cycle consisting of 20 minutes of actual operation with a 10-minute stop for cooling. During the stop period a special cooling system reduced the temperature so that the engine was started from a cold condition at the beginning of each half-hour period.

Results of these tests, in which the average cylinder wear was about 0.000,02″ per 1000 miles of operation, verify a previously-accepted theory that operating conditions have a decided effect on cylinder wear, there being in general a greater amount of wear when starting the engine at low temperature than at high temperature (50°C). The data provided by such sensitive determinations of wear also indicated the possibility that corrosion is responsible for a major part of the wear occurring in normal operation of an engine. It is believed that moisture condensing on cold cylinder walls serves as a base for the formation of corrosive acids from the gases in the products of combustion. It appears that engine life may be substantially increased by any feature of design that accelerates the engine warm-up or prevents the temperature of the cylinder walls from falling below the dew-point of the exhaust gases. Additional data on corrosive qualities of fuels would be desirable.

The indentations used in the studies at the Bureau were made by impressing into the test surface the apex of a four-sided pyramid. From the standpoint of accuracy the chief limitation is that the sharp points of the marks are blunted somewhat when wear occurs. Possible use of cutting or grinding methods for producing marks without burrs and without sharp-pointed ends presents a promising field for further investigation. If this can be accomplished, the accuracy of determining wear would be greatly increased.

The new method provides the particular advantage of an indication of wear only, while the usual measurements of changes in diameters of the pistons and cylinders do not differentiate between wear and distortion that may occur during a test. It also indicates wear at a particular point on the surface, whereas measurements of diameter involve changes at two points and practical means are not generally available for determining the amount of wear at each point. Also, the method does not require the careful technique necessary to measure diameters with corresponding accuracy.

As temperature variations do not materially affect the accuracy with the indentation method, it is not necessary to bring the cylinder to a definite temperature before making the measurements. The apparatus is provided with locating pins and is so arranged that a mark made at given pin settings will fall within the field of vision of the periscope at the same settings. This eliminates loss of time in searching for the marks which are too small to be readily discernible to the eye.

In addition to its use as a practical method of measurement of wear in aircraft and automotive engine cylinders, the indentation method appears applicable to other machine elements, gages, dies, and wearing surfaces where the material is of such a nature that the indented marks will retain their shape in service. For example, a mark placed on the wearing surface of certain production dies would readily indicate when it had been worn beyond specified tolerances.

Extensive tests at the Bureau have provided conclusive evidence that the indentation method of determining wear overcomes the shortcomings of other methods.

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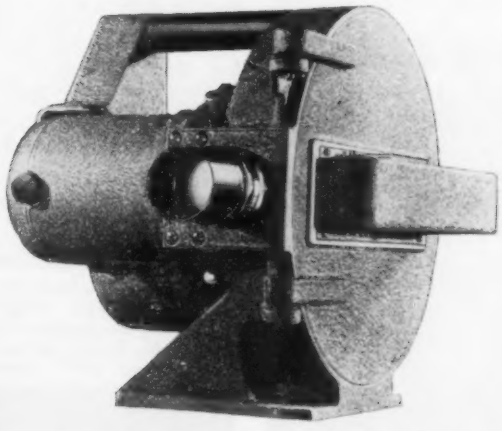

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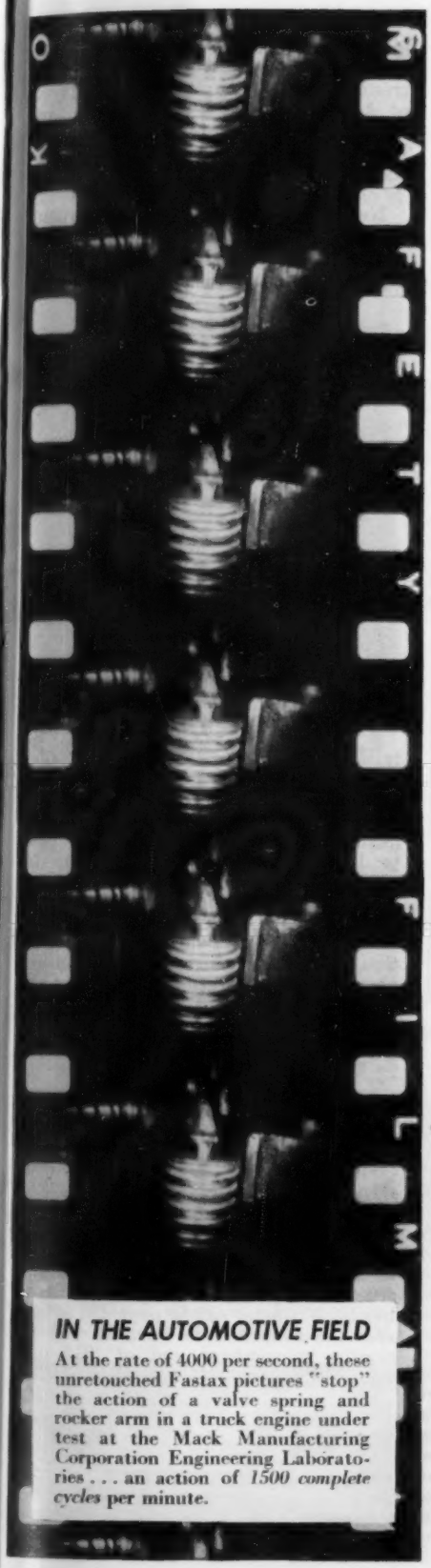

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The Month's NEW INSTRUMENTS

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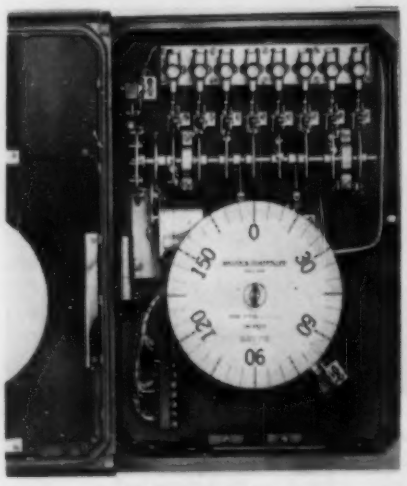
Process Program Controller

New "Model C500 Impulse-Sequence Cycle Controller" is a multiple-cam controller which actuates or engages, at correct time in each cycle, mechanical, electrical, or pneumatic devices for automatically carrying out intended schedule. Time measurement and pilot valve operation are handled by separate mechanisms, giving flexibility of application. Timing is accomplished by

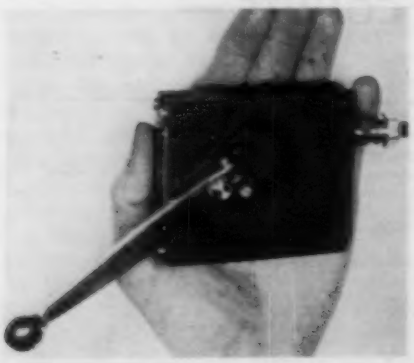


a Telechron-driven aluminum disk with a 25" time scale on which desired schedule is cut by cutting notches with a notching punch. It is said that disks for new cycles or schedules can be easily made. Time impulses are transmitted electrically. Cams are individually adjustable and their setting is said not to require fine adjustment in order to get accurate results. — *The Bristol Co., Waterbury 91, Conn.*

Please mention number 701 when filling out card

Motion-transmitting System

New "Type HC 08 Miniature Hydraulic Remote Control" is said to establish a new record in light-weight class. It has a torque capacity of 50 lb.-in. on pressure stroke and is rated as much as 50% more powerful than maker's earlier and slightly heavier model. Transmitter, receiver and single-line tubing form a self-contained hydraulic system. Only two small bolts are required to mount each unit in place, at distances up to 35 feet. New system provides "feel" control of a distant mechanism since any motion of transmitter arm is duplicated by receiver arm. Either arm will move through an arc of 60° and receiver arm may be drilled at any location to obtain desired linear travel of actuated rod. —*Sperry Products Inc., 15th St. & Willow Ave., Hoboken, N. J.*



Please mention number 702 when filling out card

Portable Vacuum Leak Detector

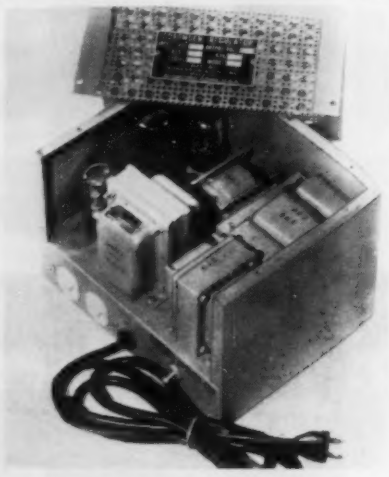
New "Model 722-SS" portable (25-lb.) high-sensitivity leak locator is designed to locate quickly and simply tiny leaks "formerly impossible to locate except with elaborate leak-detection equipment." It is a hydrogen-sensitive ionization-type instrument, simple enough to be operated by non-technical personnel. Heart of new leak locator is new "Type 1945" sealed-off high-vac-

uum gage tube, which responds only to hydrogen. Instrument itself is complete with a high-stability d-c. amplifier, microammeter, self-contained power supply, and all-metal exhaust system and cold trap, contained in a 10½" × 10½" × 14" wide cabinet. In operation, electron tube (for example) under test is plugged into vacuum port on leak detector before tubulation is "tipped off." Vacuum is created in system. A hood is lowered over tube and filled with hydrogen. If tube is leaky, hydrogen penetrates leak and increases grid current of "Type 1945" tube. Amplified current deflects microammeter on locator. Exact location of leak may then be determined by playing a small jet of hydrogen over suspected areas. Large vacuum enclosures, which cannot be plugged into vacuum port on the instrument, can be connected to vacuum-system connection hose and leaks can then be located by moving small jet of detecting gas over suspected areas. Optional equipment: portable table-height stand, motor-driven rotary vacuum pump, and voltage-regulating transformer.—*Tube Dep't, Radio Corp. of America, Camden, N. J.*

Please mention number 703 when filling out card

A-c. Voltage Regulator

New "Model 150" general-purpose portable a-c. voltage regulator features electronic control circuits, is designed for component applications with elec-

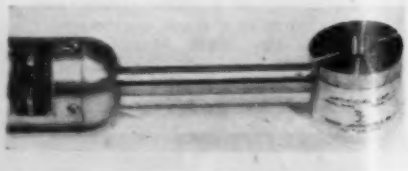


trical equipment utilizing light loads; has an input voltage range of 95 to 125 volts with an output of 115 volts. Regulation accuracy 0.5%; maximum harmonic distortion 5%; load range 10% to 100%; frequency range 50 to 60 cycles; power factor range 70% lagging to 90% leading; maximum recovery time six cycles. Among applications for new model are laboratory, production and quality control test equipment, photometric apparatus, etc. Dimensions of gray enamel case 9" × 7½" × 6". —*Sorensen & Co., Inc., 375 Fairfield Avenue, Stamford, Conn.*

Please mention number 704 when filling out card

Artificial Ear Coupler

New "Model M-112 Artificial Ear Coupler" is a two-piece stainless steel structure which provides either a 2-cc. or a 6-cc. closed chamber for use in obtaining response characteristics of earphones: smaller volume for calibration of insert type earphones; larger cavity for earphones generally worn with head bands. Artificial ear is provided with a specially-shaped side opening for inserting microphone end of "GA-1002 Sound Pressure Measurement Equip-

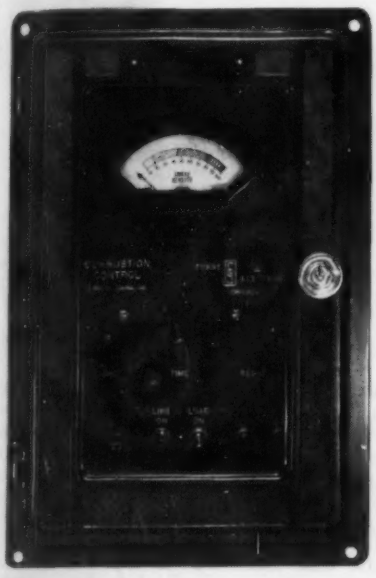


ment." (Or "Model M-101" standard microphone may be inserted as the pressure-responsive element.) Both cavities have been designed for minimum linear dimensions of opening, to avoid low-frequency standing-wave errors. Extremely high acoustic impedance of the M-101 microphone requires no "soft diaphragm" correction for the chamber volume to frequencies beyond 20,000 cycles.—*Massa Laboratories Inc., 3868 Carnegie Ave., Cleveland 15, Ohio.*

Please mention number 705 when filling out card

Combustion Controllers

New "Model 111 Photoelectric Combustion Controls" were designed for use in "over-fire-air" systems of steam boilers and are used to control operation of

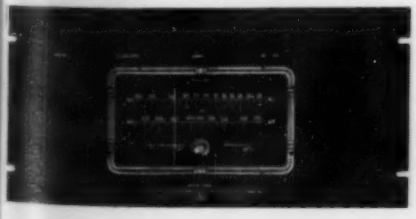


blowers and other air-handling equipment which are started automatically when appearance of smoke indicates an inadequate air supply. They feature a self-adjusting time-delay of relay contacts so that length of time during which blowers operate is automatically set to furnish proper amount of air. Illustration shows "Model 111-F" control box for flush mounting. (Not shown are light-source unit and phototube-and-preamplifier unit.) Except for relay armature there are no moving parts in entire system. — *Furst Electronics, 800 W. North Ave., Chicago 22, Ill.*

Please mention number 706 when filling out card

FM-AM Tuner

New "Model RJ-14 FM-AM Tuner" in rack panel style for commercial or other application uses entirely separate circuits for FM and AM, thus eliminating dual purpose components. AM section is of superheterodyne type employing an r-f. stage and having "excellent sensitivity and selectivity." FM



section uses Armstrong circuit with dual limiters and covers 88 to 108 Mc. band. RF stage, mixer, and oscillator are of miniature type for best efficiency. A bandswitch on panel selects FM, AM, or phonograph input all of which are fed through a gain control also on front panel. Dimensions: 19″ × 8¾″ × 9″; weight: 28 lbs. — *Browning Laboratories, Inc., 742 Main St., Winchester, Mass.*

Please mention number 707 when filling out card

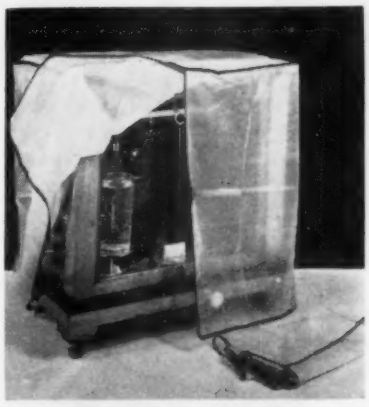
Keying Relay

New "Model RX-1074-1" keying relay is designed for minimal space (2⅜″ × 1⅝″ × 1⅜″ high) and for maximal resistance to shock and vibration (less than 2% change in marginal operating current under 2000*G* linear acceleration; no false contacting under 10*G* harmonic vibration). Contacts handle 5 amps. at 115 volts a.c. Relay will respond to 20 pulses per second on 5-ma. coil current when connected to 90 volts d.c. through a series resistor (0.125 watts in coil). At higher coil voltages it can follow 40 to 50 pulses per second. Relays can be supplied in hermetically-sealed cases. — *Signal Engineering & Mfg. Co., 152-8 W. 14th St., New York 11, N. Y.*

Please mention number 708 when filling out card

Plastic Instrument Covers

New flexible transparent plastic covers for instruments and laboratory equipment afford protection against dust, dirt, spilled liquids etc.; permit



observing instrument. Covers are made of a semi-transparent flexible non-hardening plastic; all seams machine sewn with a heavy-grade black basting (other colors available). Loops for removing covers as well as overlaping flaps are optional. Standard covers for pH meters, balances and scales are in stock; special covers in single lots or quantity can be supplied promptly.—*Baker Instrument Co., 17 South Day St., Orange, N. J.*

Please mention number 709 when filling out card

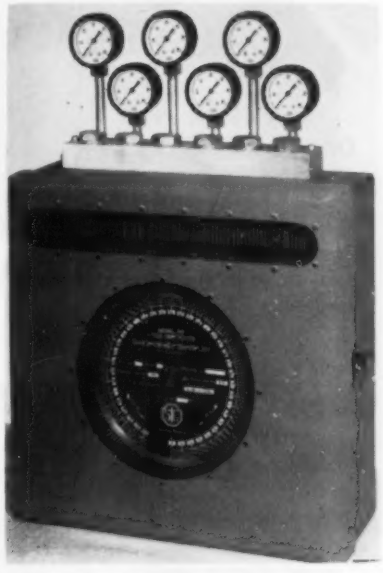
Attenuators with "Oilite" Bearings

New standard units in maker's line of attenuators have two permanently-lubricated "Oilite" bearings, one at switch end and the other at shaft or detent end, yet are being offered at no additional cost.—*The Daven Co., 191 Central Avenue, Newark, N. J.*

Please mention number 710 when filling out card

Process Program Controller

New "PB2 Time Cycle Controller" starts, times, stops and correlates multiple operations in any process or machine cycle which can be actuated by air pressure or electricity. Applications include plastic and rubber molding equipment, chemical and food industries, etc., especially in operations where frequent changes are desired, because it provides unlimited flexibility of scheduling which can be varied at will without use of tools and without changing parts. Air control is integral (does not require intermediary of solenoid valves). Pilot valve action is as rapid in longest schedules as in shortest. Time selector wheel carries 150 keys, selectable to provide timing, to within 0.67% of over-all time range, for each

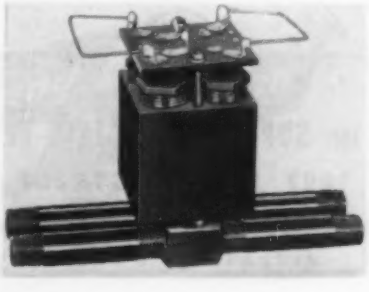


successive event scheduled in operation selector. Standard cycles available to 750 minutes. Operation selector camshaft with ten working positions operates pilot valves or precision switches in any desired sequence. Time and sequence sections are driven by gear-head motors of ample power. Resetting is automatic at completion of program, requiring one second per unused operation.—*Seely Instrument Co., Inc., 315 Fourth St., Niagara Falls, N. Y.*

Please mention number 711 when filling out card

Thermal-conductivity Cell for Gas Analysis

New "Thermal Conductivity Unit" can be used with standard instruments and accessories, as found in any laboratory. It incorporates four filaments assembled in appropriate chambers and wired in a balanced bridge arrange-



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2. Looping of wire around the center shaft and clamping.
3. Plug-in of standard ¼" banana plug.
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ment. With a suitable source of constant voltage, degree of unbalance of bridge circuit provides an accurate measure of relative thermal conductivity of an unknown gas, or quantitative variation in a known gas. New cell may be used with indicating, recording or controlling instruments. It measures 1½" × 3½" × 2⅜". It is relatively unaffected by vibration or ambient and current change. Each cell is tested at 10 lbs./in.² before shipment.—*Gow-Mac Instrument Co., 22 Lawrence St., Newark 5, N. J.*

Please mention number 712 when filling out card

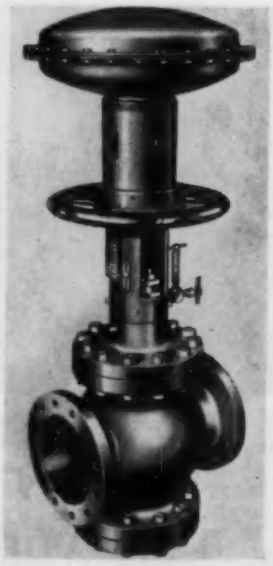
Air-compressor Safety Valve

New safety valve for air compressors utilizes a Nylon disk, "the only material found which possesses all the essential characteristics of wear resistance, hardness and flexibility . . . will not flow or creep under spring compression nor stick or weld itself to the seat . . . has a recovery characteristic which quickly seals off the slightest air leakage after the valve pops." New valve meets all A.S.M.E. requirements for air compressor service. — *Manning, Maxwell & Moore, Inc., Bridgeport, Conn.*

Please mention number 713 when filling out card

Continuously-connected-hand-wheel Diaphragm-motor Valve

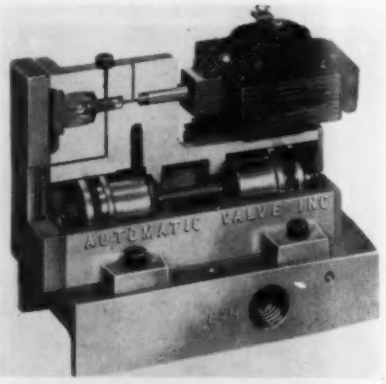
New "Continuously Connected Handwheel Valve" obviates need of conventional by-pass, as it is powerful enough to operate control valve manually, regardless of maximum instrument air pressure on diaphragm or in opposition to spring. It is, therefore, possible to position valve plug by hand under any conditions, by turning handwheel to required position. Control valve characteristics are, of course, the same whether on automatic or hand control. Travel limit stops can be set to limit valve stroke from 0 to 100%. For example, to permit a 25% valve travel, located at any point from fully closed to fully open. Should any air failure occur, control valve plug could only change its position ±12½%; operator could immediately position valve plug to proper position by turning handwheel. This can be done even if valve spring in diaphragm control valve has also failed. Handwheel can be used to shut valve tightly or block valve wide open. Valve plug position indicator shows setting of travel stops, percent free travel of valve plug and in what portion of valve stroke free travel can occur, also whether handwheel is in a neutral position. Handwheel may be applied to any of maker's valves, 2" to 12".—*Hammel-Dahl Co., 243 Richmond St., Providence, 3, R. I.*



Please mention number 714 when filling out card

Solenoid Valve

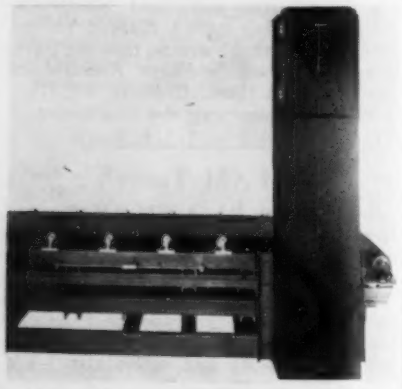
New "SV-3" 3-way 3-port solenoid-operated air valve for controlling single-action air cylinders can be attached close to air cylinders in any position and can easily be serviced without disturbing piping. Normally open or closed, it is reversible in servicing and assembly. There are no metal contacts (O-ring type seals). "SV-3" is available in ¼", ⅜", ½" and ¾" sizes; pressures from 5 to 150 lbs./in.². Operation power valves are 1.42 amp. at in-rush and 0.22 amp. sealed, for 110 volt 60 cycles.—*Automatic Valve, Inc., 37415 Grand River, Farmington, Mich.*



Please mention number 715 when filling out card

Dry-material Continuous Weigher

New "Conveyoflo Meter" for continuous weighing of dry materials on conveyor belts utilizes diaphragms instead of usual knife-edge-beam principle, is said to be much simpler unit and to occupy less space than usual conveyor scale. Scales may be used to proportion and control, as well as weigh, the feed of one or more dry materials, and to control flow of liquids in proportion to flow of dry materials. Weighing section of "Conveyoflo Meter" is supported at one end by self-aligning ball-bearing



pillow blocks, other end "floats" on a diaphragm which transmits load changes hydraulically to the weighing mechanism. Cyclometer type totalizer reads directly in any unit desired, is non-cyclical in operation (employing disk-and-wheel integrating principle) and is automatically corrected for any belt speed variations. Integration is automatically compensated for variations in belt weight and for adherence of material to the belt, through a system of return belt weighing.—*Builders-Providence, Inc., 9 Codding St., Providence 1, R. I.*

Please mention number 716 when filling out card

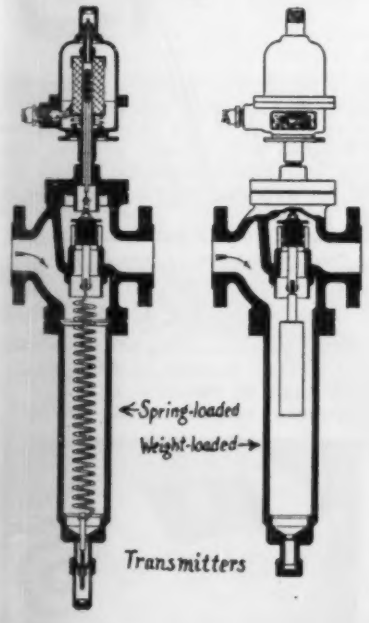
Motorized Valve

New motorized valve provides automatic two-position (on-off) operation of valves for steam, air, gas, oil or water. Induction type motor drives through worm-and-gear reduction. Limit switches are adjustable. Cast iron housing is dust-tight and splash-proof; all parts are easily accessible. Actuated by 3-wire thermostat, pressure switch or other similar instrument; operates from either 24-, 110- or 220-volt a.c. Valves supplied: Globe bronze, single or double-seated in sizes ½" to 2½" screw-end connections; Butterfly valves, iron body, bronze trim in sizes 1" to 4" either screwed or flanged ends. Delivery four weeks.—*Automatic Temperature Control Co., Inc., 34 East Logan St., Philadelphia 44, Pa.*

Please mention number 717 when filling out card

Area Type Fluid Meter

New Area Meter is said to accurately measure viscuous liquids: black liquor, tar, chemicals, distillates, etc. (as well as water, oil, gasoline, etc.).



It consists of a telemetering transmitter installed in pipe line, much like a valve; and maker's standard receiving instrument (indicating, recording, integrating, controlling or combination). New Area Meter is said to have several advantages over other types of flow meters: its installation is simplified as

Off the Drafting Board...

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Consolidated Type 5-115 Recording Oscillograph

LIGHTER, SMALLER, 36-TRACE

Recording Oscillograph

The many features that you asked for in Recording Oscillographs are now found in the new Consolidated Types 5-115 and 5-114. Consolidated Type 5-115 Recording Oscillograph will record up to 36 traces and is approximately 25% lighter and 25% smaller than previous models. Five times as many records can be taken on the same length recording paper or film through the use of reduced-amplitude recording. A single switch controls operation. The paper magazine is readily detachable and spares can be installed in full daylight.

Type 5-114 Recording Oscillograph will record up to 18 traces and is similar in appearance and operation to the 36-trace model. The accuracy and sensitivity of the new smaller Type 7-200 series galvanometers correspond to the same standards that Consolidated has held to in the past. Complete data on these new instruments can be obtained by writing to

Features

- Lighter, more compact than ever!
- 12-v, d-c operation; models also available for 115-v, a-c operation.
- Interchangeable galvanometers for a wide range of frequencies.
- Individual input connectors to galvanometers
- complete paper-speed range from 1/16 to 50 in. per sec.
- Automatic operation for any length record from one to 55 inches.
- Footage indicator for unused film or paper.
- Automatic numbering at the end of each record or at fixed lengths.
- Thermostatically controlled heaters to assure constant damping for low-temperature operation.
- Panel lights for indicating correct operation of circuits at all times.

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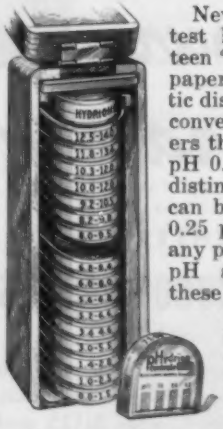
recorder is constructed of packaged components not affected by vibration; recorder may be calibrated to read in terms of volumetric units thereby reducing errors due to density changes; two transmitters may be connected to the same recorder to measure ratio, sum or difference of two flows. Transmitter has a port area varied by a plug restrained with a calibrating weight or spring. Plug assumes a position proportional to rate of flow, its movement causing a voltage ratio variation in telemeter circuit. Receiver employs an impedance bridge measuring circuit which is extremely sensitive to any unbalance in voltage ratio and therefore reacts to slightest movement of plug. Transmitters are available in 1" and 2" pipe sizes, various ranges and various maximum pressures, cast iron and cast steel bodies, 200°F. maximum fluid temperature.—*Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.*

Please mention number 718 when filling out card

pH Test Papers

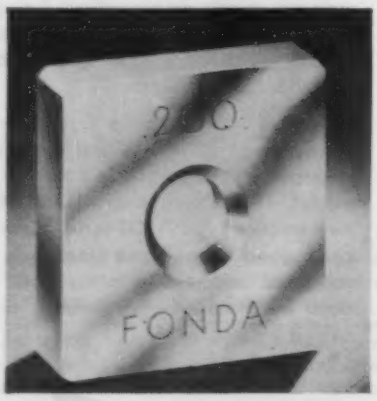


New "Set H-20" pH test kit contains nineteen "Hydrion" pH test papers in eighteen plastic dispensers, all in one convenient case. It covers the full range from pH 0.0 to pH 14.0, and distinct color changes can be obtained within 0.25 pH unit of almost any point of interest on pH scale. Eleven of these papers are now released for the first time.—*R. P. Cargille, 118 Liberty St., New York 6, N. Y.*

Please mention number 719 when filling out card

Square Gage Blocks

New square gage blocks supplement rectangular "Lifetime-Carbide" gage blocks. This is said to be the first time



that a full range of sizes, in square style gage blocks, have ever been offered in carbide. New square style blocks are available in both Grade "A" (±0.000004") and Grade "B" (±0.000008") and in full range of sets and sizes heretofore available only in rectangular style.—*Fonda Gage Co., Stamford, Conn.*

Please mention number 720 when filling out card

Industrial Stop Watches

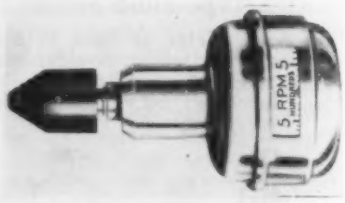
New "Coil-Spring Mechanism" stop watches are recommended for industrial, scientific and research use. "Non-breakable, rust- and corrosion-proof

coil-springs" are said to eliminate friction and wear and to assure continual accuracy and longevity. "Independent Hammer Spring" is said to assure lifetime fly-back to zero, and "Brake System" to eliminate any variation at zero when starting and stopping. It is said "non-breakable coil-spring" system of construction will prevent annoying breakdowns and reduce maintenance costs.—*M. Ducommun Co., 580 Fifth Ave., New York 19, N. Y.*

Please mention number 721 when filling out card

Hand Tachometer

New hand tachometer makes possible quick checking of speeds, both clockwise and counter clockwise, contains



many features of maker's regular tachometer but its small size permits operator to hold it in his palm. Tachometer is finished with chrome plating, comes with two interchangeable rubber tips, one for recessed shafts, the other for flat surfaces.—*AC Spark Plug Div., General Motors, Flint 2, Mich.*

Please mention number 722 when filling out card

Moisture Meter

New "Direct-reading Electronic Moisture Meter," capable of measuring the percentage of moisture in almost any substance, requires no calibration

curves or charts, compensates automatically for temperature of substance being measured, reports percentage moisture in fifteen seconds. It is said that moisture percentages up to 85-90% can be measured with accuracy comparable with that of oven-balance methods.—*C. J. Patterson Co., 3947 Broadway, Kansas City, Mo.*

Please mention number 723 when filling out card

Pedestal Mount for Tachometers

New "Type 66" pedestal mounts can be used with all maker's "Type 52" heads where rotating speed (for full-scale reading) is between 100 and 10,000 rpm. Their low cost and flexibility are said to obviate, in many cases, need to build costly mounting brackets. Head is mounted on upright column which is adjustable in base to obtain alignment. Head can be rotated about vertical axis and adjusted up and down. Electrical indicator connections are made through ½" conduit fittings. Heights up to 4 feet from base to shaft center; minimum height 3¼". Base can be mounted on a floor, ceiling, wall, machine member or any other convenient surface.—*Metron Instrument Co., 432 Lincoln St., Denver 9, Colo.*

Please mention number 724 when filling out card

Altimeter-setting Indicator

New "Altimeter Setting Indicator" for use at airport control towers, airway control stations and weather stations, has been developed to increase safety in instrument landings. It gives direct, continuous and extremely accurate readings of prevailing sea-level pressure; has a wide (3400-ft.) range of station elevation settings. Announcement states that "airports have until

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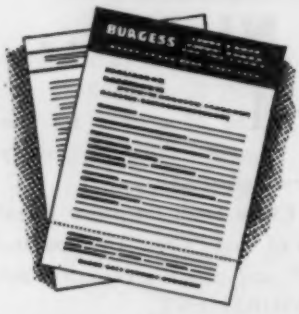

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now depended on mercurial barometers or sensitive altimeters, mounted in the control tower. In the first case every reading had to be computed and in the second, resetting was required for each reading. . . . Altimeter Setting Indicator eliminates the human factor of both computation and adjustment by continuously and automatically indicating the exact setting number." Dial is standard 6" control tower panel size, calibrated in hundredths of inches for 28" to 31" of mercury. Movement of aneroid diaphragm is translated to pointer through a high-precision gear train; hysteresis and friction are minimized by frictionless spring suspension in place of pivots and jewel bearings. —*Kollsman Instrument Div., Square D Co., 80-08 45th Ave., Elmhurst, N. Y.*

Please mention number **725** when filling out card

Flush-mounting Tachometer Indicator

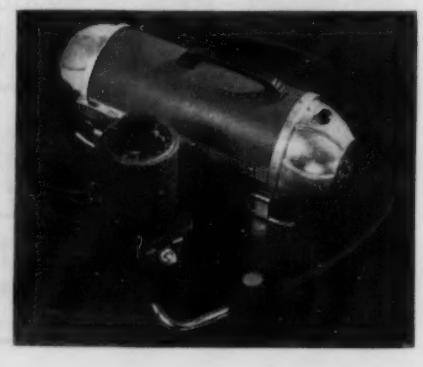
New tachometer indicator for flush mounting on switchboards is supplied in any one of 50 standard scales covering speeds from 1 rpm. to 100,000 rpm.;

multiple-range features can be incorporated. It can be used with any of maker's tachometer heads; or equipped with a rotary selector switch to monitor several speeds from a centralized location. Panel dimensions 7½" × 9¾" with 4⅝" projection behind front surface of the panel. Connections are made to terminals on rear.—*Metron Instrument Co., 432 Lincoln St., Denver 9, Colo.*

Please mention number **726** when filling out card

Vacuum Pick-up for Abrasion Tester

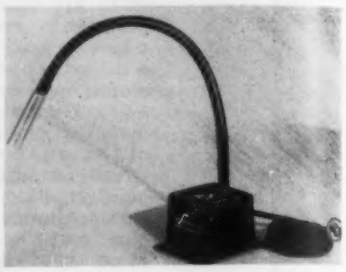
New "Model 100-108" Vacuum Pick-up Attachment for maker's "Abraser" rapidly removes abraded particles from specimen, provides uniformly effective contact of tester's abrading wheels against surface of specimen. Suction nozzle assembly is mounted on right-hand arm support of instrument and adjusted to correct height for thickness of specimen. Attachment operates on 115-v. 50/60 cycle supply, is adaptable to 230-v. 50/60 cycle with use of a transformer.—*Taber Instrument Corp., 111-I Goundry St., North Tonawanda, N. Y.*



Please mention number **727** when filling out card

Toolmaker's Spotlight

New "Opti-Spot" is a small self-contained toolmaker's spotlight operating on 110-volt a.c., voltage being reduced

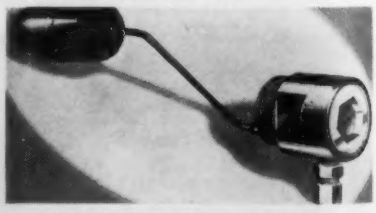


by a transformer. Light cell contains a focusing condenser lens by which size of spot can be varied. Lamp is ordinary 6-volt automotive type, allowing for easy replacement. Heat is negligible so that work distortion from this cause is eliminated. Two models: "Model A" has 16" flexible tubing connection between lamp and base which maintains adjustment of lamp position. "Model B" has an 18" rubber-covered cord between lamp and base. Both are equipped with ON-OFF switch mounted in transformer housing.—*Benton Co., 351 S. LaBrea Ave., Los Angeles 36, Calif.*

Please mention number **728** when filling out card

Air Charging Controller for Water Tanks

New "Type B Automatic Air Charging Control" is designed to maintain a constant volumetric relationship between air and water in storage tank



of domestic water systems without being affected by the length or frequency of the pump cycle. Air is admitted to tank only when required, is shut off automatically when tank contains sufficient air under pressure to operate the water system properly.—*U. S. Gauge Div., Am. Machine & Metals, Inc., 44 Beaver St., New York City.*

Please mention number **729** when filling out card

Gas Flame Failure Safeguard

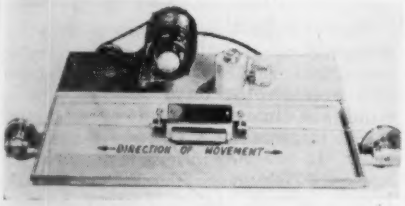
New "Fireye Electronic Flame Rod Type 45JQ1" is readily applicable to all types of gas-fired burners. It is used with "Programming Control Type

24PJ8" for full automatic burners; with "Control Type 24QJ5" when only operating protection is required. Various combinations of auxiliary exhaust fan timers and relays are also available. Specifications: Supply: 115/230 volts, 50/60 cycles; Output: controls gas valve, burner motor and ignition system; Ambient temperature: 30-125° F. —*Combustion Control Corp., 77 Broadway, Cambridge 42, Mass.*

Please mention number 730 when filling out card

Washability Tester

New "Straight Line Model 105 Washability Machine" is announced as "far superior to Model 104 which . . . has been in general use in testing labora-



tories." Operation is simple: test panel may either be clamped to table or placed in table pan. Apparatus is run until desired number of oscillations (double-strokes) has been registered on counter or until test film has shown failure within 4" area measured 2" in each direction from center of test panel. Speed of brush is 37 oscillations per minute. New apparatus can be used to make tests under Navy 51 C-20 C, Federal TT-P-23a, -88a, etc., also for various other physical property determinations: glossiness of waxes, ease of cleaning of metal polishes, abrasive resistance, detergency power of soaps, etc. (also as store-window demonstrator).—*Henry A. Gardner Lab., Inc., 4723 Elm St., Bethesda 14, Md.*

Please mention number 731 when filling out card

Photocopy Attachments

New "Stewartry Copying Attachments," originated in Scotland are now being distributed in the U. S. They facilitate microfilming of documents, close-up photography of dental, medical and scientific subjects; also for photomicrography by substituting a standard microscope for camera lens. Attachments are composed of several independent but coöperating devices. Basic attachment used with all cameras is Copying Arm, fitted with a clamp base which may be attached to any en-

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SORENSEN SYSTEM NOW APPLIED TO DC VOLTAGE REGULATION

The Sorensen system of AC electronic voltage regulation provides quick, accurate response to even the smallest voltage change with a minimum wave distortion and a regulation accuracy of ½ of 1%.

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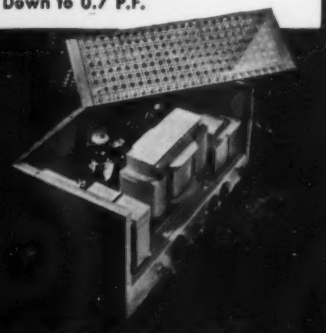
This same electronic regulation system has been incorporated into the Nobatron, providing a source of regulated DC voltage at currents and stabilities that, in the past, was available only with batteries.

This new source of stabilized DC voltage is obtainable in six standard models operating on a 95-125 AC source of 50 to 60 cycles.

Among the more important uses for Nobatrons are DC ammeter calibration in experimental and quality control laboratories, testing of components in the automotive and aircraft industries in battery-operated relays and in other applications where it is desirable to replace a battery to guarantee continuous regulated power supply.

GENERAL AC REGULATOR SPECIFICATIONS

Input Voltage Range	(—1 model)	95-125
	(—2 model)	190-250
Output Voltage Range	(—1 model)	110-120
	(—2 model)	220-240
Load Range		25-30,000 V. A.
Regulation Accuracy		½ of 1%
Harmonic Distortion		5% Max. (2% in "S" Models)
Input Frequency Range		50-70 cycles
Inductive Power Factor Range		Down to 0.7 P.F.



For standard voltage regulation, Sorensen Model 500 is a proven leader in its field—compact, accurate and dependable. This model typifies the Sorensen line of AC and Nobatron all-purpose voltage regulators. Let a Sorensen engineer help you with your next voltage regulation problem.

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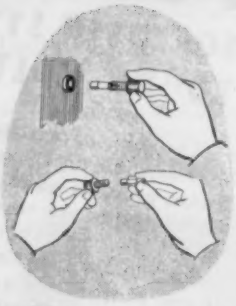
375 FAIRFIELD AVENUE • STAMFORD, CONNECTICUT

Safe, "dead front" Littelfuse Extractor Fuse Mounting Posts are easy to install. They save panel space—can be ganged in rows with a common bus.

Fuse holder is in end of removable knob—unscrew it and fuse is quickly extracted and changed with fingers.

Finger and screwdriver operated types in 3AG and 4AG sizes now are available.

Catalog number 9 gives you complete details, write for yours today.



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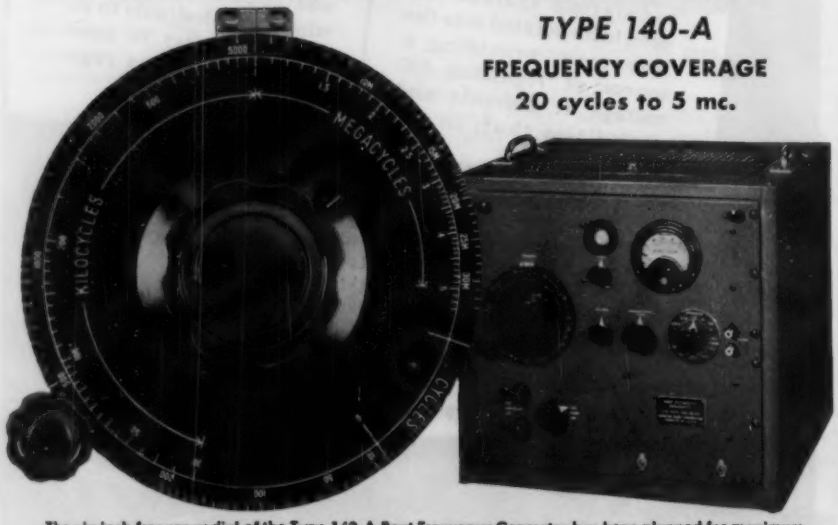
BEAT FREQUENCY GENERATOR

TYPE 140-A

FREQUENCY COVERAGE
20 cycles to 5 mc.



The six inch frequency dial of the Type 140-A Beat Frequency Generator has been planned for maximum readability and rapid setting, with combined scale lengths of the low and high ranges exceeding 22 inches. Continuous coverage of the entire audio spectrum is possible without bothersome range switching.

SPECIFICATIONS:

Frequency Range: 20 cycles to 5 megacycles in two ranges. ***Low Range:*** 20 to 30,000 cycles. ***High Range:*** 30 kc to 5 megacycles. ***Frequency Calibration:*** Accuracy ±2 cycles up to 100 cycles, ±2% above 100 cycles. ***Adjustment:*** High and low ranges have individual zero beat adjustments. Low range may be checked against power line frequency with front panel 1 inch cathode ray tube. ***Output Power and Impedances:*** Rated power output: one watt, available over the low frequency range from output impedances of 20, 50, 200, 500, 1000 ohms, and over both ranges from an output impedance of 1000 ohms. ***Output Attenuator:*** Five steps: X1.0, X0.1, X.01, X.001, X.0001. Distortion: 5% or less at 1 watt output; 2% or less for ½ voltage output. ***Write for Catalog "D"***

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BOONTON·N·J·U·S·A

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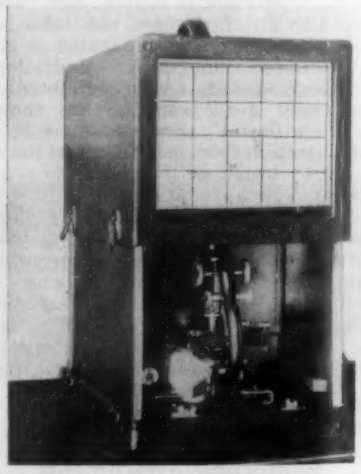
THE Q METER · QX CHECKER
FREQUENCY MODULATED SIGNAL GENERATOR
BEAT FREQUENCY GENERATOR
AND OTHER DIRECT READING INSTRUMENTS

larger post, pipe or bar having a diameter between 1¼" and 2½". End of arm terminates in a screw which not only fits Copying Attachments, but takes any camera using American standard tripod screw. Copying Attachments mount on Copying Arm and accept lenses of Contax, Leica and Kardon cameras. Rear surface accepts external bayonet of Contax camera. Focusing screen is placed at exact distance of the film in camera. With collapsible mount lenses, full range of focusing from infinity to 15" is accommodated. For working closer than 15", standard extension tubes may be fitted to either Copying Attachment.—*Caprod, Ltd., 125 W. 31st. St., New York 1, N. Y.*

Please mention number 732 when filling out card

Dust-counting Microprojector

New "Dust-Vue Microprojector" is designed to simplify determination of numerical concentrations of impinger and precipitator dust samples, and to eliminate time-consuming eye-straining direct microscope-counting of dust particles. It projects microscopic field image on a 250mm. × 200mm. ruled translucent screen, magnification 1000×. This makes dust-counting faster, easier

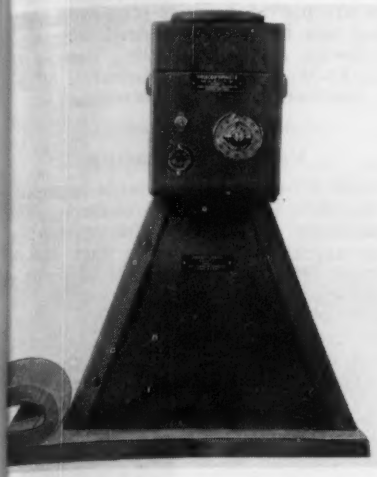


and more accurate; enables dust particles to be distinguished from pits and bubbles in glass of cell; permits more concentrated samples to be counted without secondary dilution. Light source is a dependable tungsten-mercury arc lamp. Any standard fork-stand type microscope can be used. A removable screen shield permits light-room counting. — *Mine Safety Appliances Co., Braddock, Thomas, and Meade Sts., Pittsburgh 8, Pa.*

Please mention number 733 when filling out card

Photocopy Machine

New portable "Model B Tru-Copy-Phote," designed for copying pages from heavy bound books, has 8½" ×

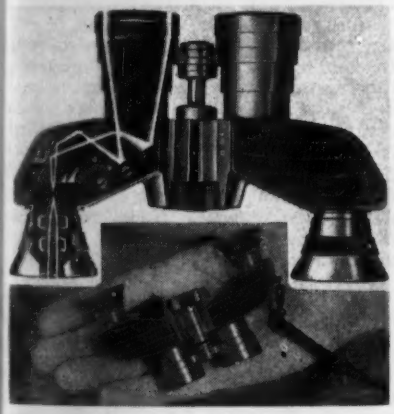


14" copy surface, is equipped with a collapsible stand which fits over copy to be reproduced. Other features: removable color filter, automatic "Time-O-Lite" timer for exposures, manual switch for shorter or longer exposures, red dark-room or warning light to enable operator to use extremely sensitive film or paper without any other means of illumination. It may be used constantly for volume production. A novice can be taught its operation in minutes. It operates on 115-volt 50/60-cycle a.c. —*General Photo Products Co., 15 Summit Avenue, Chatham, N. J.*

Please mention number 734 when filling out card

Pocket-size Binocular

New "Sard Sportsman" 6 × 20 prismatic binocular is said to "compare optically with the best in binoculars." Its 4½-oz. weight is said to be one-



quarter and its size (see illustration) one-third of standard binoculars of similar power. It employs Leman prism, an inverting system consisting of a single piece of optical glass that transmits more light than two-prism system found in conventional binoculars because it has a much shorter light path within glass and only two transmitting surfaces as against four. Lenses also are designed for short light path within glass characteristics and optical surfaces coated so that light losses are further reduced. New binocular is ad-

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For vertical measurements on objects located near sources of dangerous radiation, within controlled atmosphere enclosures, or otherwise inaccessible.

Range of measurement: 100 cm.
Reading by vernier to 0.05 mm.
Range of working distance: 60 cm. to infinity.
Magnification: 17.5X at 60 cm.; 8.5X at infinity.

The carriage is counterbalanced and provided with delicate height adjustment. Widely separated bearings for the vertical guide bar keep the optical axis of the telescope accurately in a horizontal plane during angular shifts.

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justable for interpupillary distance and has central focusing with separate eye-setting. Instead of conventional shoulder strap, "Sportsman" comes with a detachable Nylon neck cord. A pigskin carrying case and a wood presentation box are provided. Price plus excise tax total less than two hundred dollars.— *Kollsman Instrument Div., Square D Co., 80-08 45th Ave., Elmhurst, N. Y.*

Please mention number 735 when filling out card

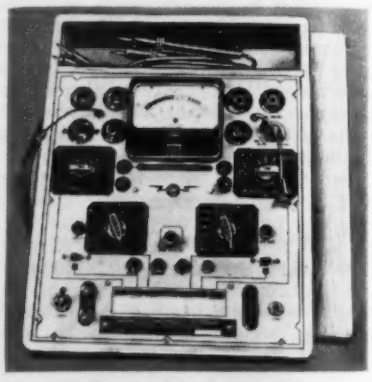
Variable Capacitor

New air-dielectric variable capacitor is suitable for industrial electronic applications, is virtually impervious to mechanical shock. It has a flash rating of 500 volts. Capacitance is adjustable from 5 mmf. (min.) to 150 mmf. (max.) by rotation through 5,000 degrees. Capacitance curve is substantially linear with rotation, and no reversals occur throughout entire range. Max. O.D. $\frac{7}{8}$", over-all length $1\frac{3}{4}$"; weight approx. 16 grams. — *North American Philips Co., Inc., 100 East 42nd St., New York 17, N. Y.*

Please mention number 736 when filling out card

Tube and Set Tester

New "Model 805B" portable tube and set tester has sockets for all standard-base tubes and for all tubes with miniature and sub-miniature bases as well. It combines a volt-ohm-milli-ammeter, tube tester, battery and capacitor leakage tester. Built-in "Rolindex" roll-chart carries full data for tube settings. New tester is said to be free from temperature and frequency errors on all a-c. measurements by use of latest type germanium crystal diode rectifier.— *Radio City Products Co., Inc., 127 West 26th Street, New York 1, N. Y.*



Please mention number 737 when filling out card

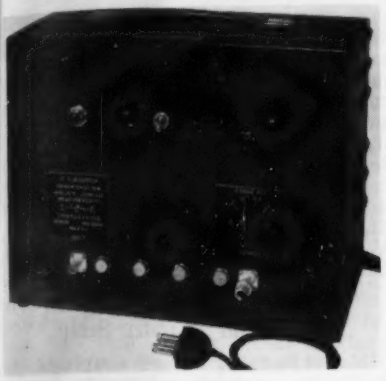
High-voltage Resistors

New "Type B" high-voltage resistors are stable, can be made in resistance value as high as 1,000,000 megohms, are particularly suited for use as VTVM multipliers, high-resistance voltage dividers, bleeders in high-voltage

television and cathode-ray tube circuits, various types of test equipment, etc. They can be furnished in tolerances of ±15%, ±10% or ±5%. A tolerance of ±2% is available as a matched pair.—*Resistance Products Co., 714 Race St., Harrisburg, Pa.*

Range-extending Converter for Signal Generator

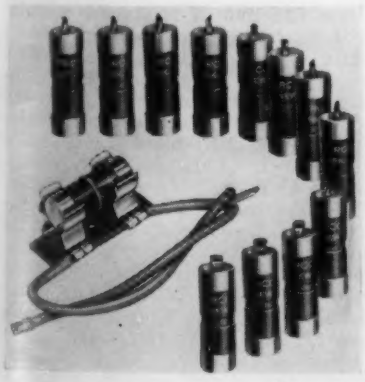
New "Model M-275 Converter," used in conjunction with maker's "Model 78 FM Standard Signal Generator" permits alignment and testing of i-f. am



plifiers and discriminators. Converter uses beat frequency method of signal generation and provides output voltages of 10 microvolts to 1.0 volt, variable with the "78-FM" attenuator, in the 4.5-Mc., 10.7-Mc., and 21.7-Mc. ranges. Provision has been made for addition of one extra frequency. Modification of "Model 78-FM" (which covers a frequency range of 86 Mc. to 108 Mc.) for use with new "M-275" is extremely simple as all necessary connections are made externally. When companion units are ordered, "Model 78-FM" is modified at the factory; otherwise complete instructions and materials are provided for this operation.—*Measurements Corp., Boonton, N. J.*

Mercury Switches

New 5-, 10-, 15- and 20-ampere hermetically-sealed mercury switches are especially adapted to explosion-proof areas. They provide mercury-to-mercury contact without arcing, pitting or burning; will operate at 110 and 220 volts a.c. or d.c. in an ambient temperature of 100°C. Pressure of hydrogen to quench the arc is 28 lbs./in.^{2} above atmospheric. Switches can stand



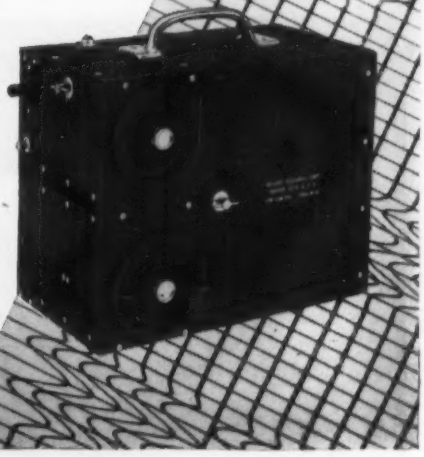
THE NEW HEILAND

12 Trace

PORTABLE OSCILLOGRAPH RECORDER

You will find the new HEILAND type A 500 R-12 recorder to be light in weight, small in size, and easily portable. You can depend on its precision accuracy and rugged construction. Where space is at a premium, and where maximum portability is desired, use this new HEILAND 12 trace recorder.

- Weight: 30 lbs. Size 12¾" L. x 9½" H. x 7⅝" W.
- Self-sustained reed timer takes accelerations up to 12 Gs
- 1/100th second timing interval lines or marks
- Reference trace in addition to 12 galvanometer traces
- Paper capacity: 4 inch width, 100 ft. length
- Paper speed: 3"/sec, 6"/sec, 12"/sec



WRITE FOR LITERATURE

HEILAND

DENVER

Maintenance and Servicing of Electrical Instruments

By JAMES SPENCER, in charge of Instrument and Relay Dep't Westinghouse Elec. & Mfg. Co., Newark, N. J.

SHOULD be of great value to all those whose problem is to keep in operation the electrical instruments on vital production equipment.

Price, $2.00 postpaid

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(RELATIVE HUMIDITY)

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Price $35

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ACCURACY — within ± 2% Relative Humidity at temperatures from — 35° F. to + 130° F. and from 15% RH to 100% RH.

SENSITIVITY heretofore unattained, response almost instantaneous.

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Your customers buy your product because they want the desirable characteristics it offers. Manufacturers buy Bodine motors for the same reason — because they want the quality and dependability these motors have always provided. You can select them to operate your product with the assurance of accuracy and reliability in service. Bodine motors are manufactured in sizes from 1/6 to 1/2000 horsepower, in synchronous and nonsynchronous types, either with or without integral speed reducers. Output speeds may be obtained as low as one revolution per minute. If you have a problem involving the use of a fractional horsepower motor, why not consider Bodine? Bodine Electric Co., 2244 W. Ohio St., Chicago 12, Ill.

Bodine motor with reducer for transmitting high torques at low speeds.

Engineered for your product

BODINE
FRACTIONAL HORSEPOWER MOTORS

400% overload for short periods. Regular size, 1½" long, ½" diameter; miniature unit, 1" long, ½" in diameter. Various switch holders are available.—*Mercontrol Inc., 278 Pearl St., New York, 7, N. Y.*

Please mention number 738 when filling out card

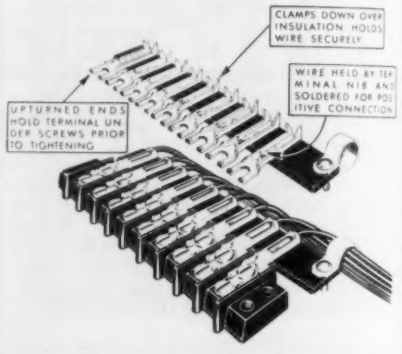
Custom-engineered Electrical Instruments

New custom-engineered electrical indicating instruments are now being produced in sample lots. This service makes it unnecessary for users requiring instruments with special characteristics to develop their own. Basis of new service is "Marion Short Run Shop" in which special-order instruments are manufactured to customers' specifications in sample lots and with a minimum of red tape. Cost is said to be much less than that of improvised instruments. User must fill out a specification questionnaire. Quotations are furnished within two days and order is shipped in about two weeks.—*Marion Electrical Instrument Co., Manchester, N. H.*

Please mention number 739 when filling out card

Terminal Wiring Strip

New "Fanning Strip" simplifies and facilitates multiple wiring to barrier terminal strips. Up to twenty wires from cable lead-in can be securely anchored to proper terminals and quickly soldered, without usual complications. Connections can be made on a bench or anywhere apart from mounted barrier strip, and entire assembly slipped into place in barrier strip "in an instant."—*Howard B. Jones Div., Cinch Mfg. Corp., 2460 W. George St., Chicago 18, Ill.*


CLAMPS DOWN OVER INSULATION HOLDS WIRE SECURELY
WIRE HELD BY TERMINAL NIB AND SOLDERED FOR POSITIVE CONNECTION
UPTURNED ENDS HOLD TERMINAL UNDER SCREWS PRIOR TO TIGHTENING

Please mention number 740 when filling out card

Miniature Selenium Rectifiers

New full line of miniature selenium rectifiers to replace rectifier tubes in radios, vibrator supplies, etc., range in size from 1" square to 1½" square, feature high current capacity, low loss, and ample safety factors. Available: "5M1," a 100-mil 5-plate stack 1" × 1" × ⅞", "5P1," a 150-mil 5-plate stack 1 3/16" × 1 3/16" × ⅞" and "5Q1," a 250-mil 5-plate stack 1½" × 1½" × ⅞". New rectifiers usually cost less than tube and components they replace; will not break; save assembly time; assure cooler operation.—*Seletron Div., Radio Receptor Co., 251 W. 19th St., New York 11, N. Y.*

Please mention number 741 when filling out card

Lever-action Switches

New "5000 and 6000 Series" lever-action switches have a wide range of applications in industrial fields and test equipment. Switch offers a total of 26 circuit combinations, 13 each shorting and positive non-shorting, including two, three and four positions, all with positive indexing at 20° between positions. Contacts will make and break 120 ma. at 110 volts d.c. and 50 ma. at 250 volts d.c., both based on resistance load for 10,000 cycles of operation. Contacts will carry 10 amperes without excessive heating. Current-carrying capacity will vary with different load, frequency and voltage conditions.—*P. R. Mallory & Co., Inc., 3029 Washington St., Indianapolis 6, Ind.*

Please mention number 742 when filling out card

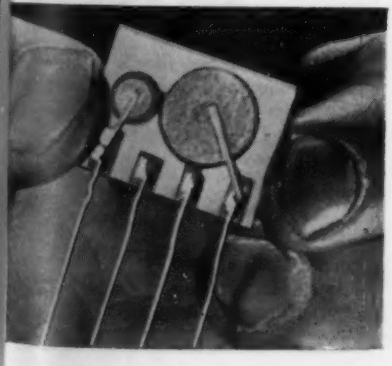
Wire-identification Labels

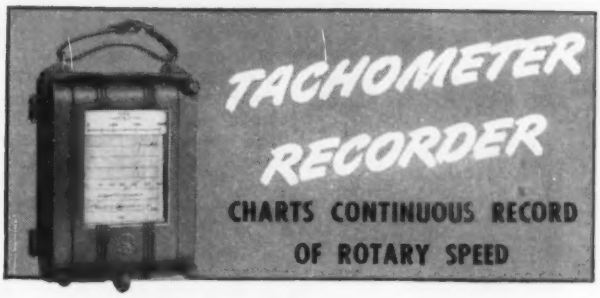
New standard cards on which are mounted self-adhesive "Quik-Label" Wire Markers (see *Instruments*, Nov. 1946, page 700) now come equipped with two "Self-Starter Strips." Standard cards have one row of 1½" long labels and with this new feature the labels can be cut in half to make each label ¾" long. First "Self-Starter Strip" aids in removal of top row of ¾" long "Quik-Labels" by automatically exposing end of each label for user to grasp instantly. After top row of labels has been used, second "Self-Starter Strip" is removed to expose ends of labels in second row. Thus user can now get twice as many labels on a card, and the shorter ¾" labels are particularly suited for marking smaller-diameter wires. All 500 stock "Quik-Label" cards now have two "Self-Starter Strips" and any card can be furnished with either 1½" labels for marking large wires, or ¾" labels for smaller wires.—*Dept. 45, W. H. Brady Co., 815 N. Third St., Milwaukee 3, Wis.*

Please mention number 743 when filling out card

"Printed-circuit" Interstage Coupling Plate

New "Couplate" interstage coupling plate is said to be the first commercial application of printed electric circuit. It is an integral assembly of two capacitors and two resistors closely bonded to a steatite ceramic plate and mutually connected by means of metallic silver paths or "printed" on base plate. All leads are always same length. Each plate is said to be an exact duplicate of original. "Couplate" assembles four components: (1) Coupling capacitor 0.01





For jobs where a continuous record of rotary speed is required, this General Electric inkless tachometer recorder, known as the Type CF-3, has proved highly satisfactory. With no ink to spill, it requires little maintenance and can operate continuously on one record roll for as long as thirty days.

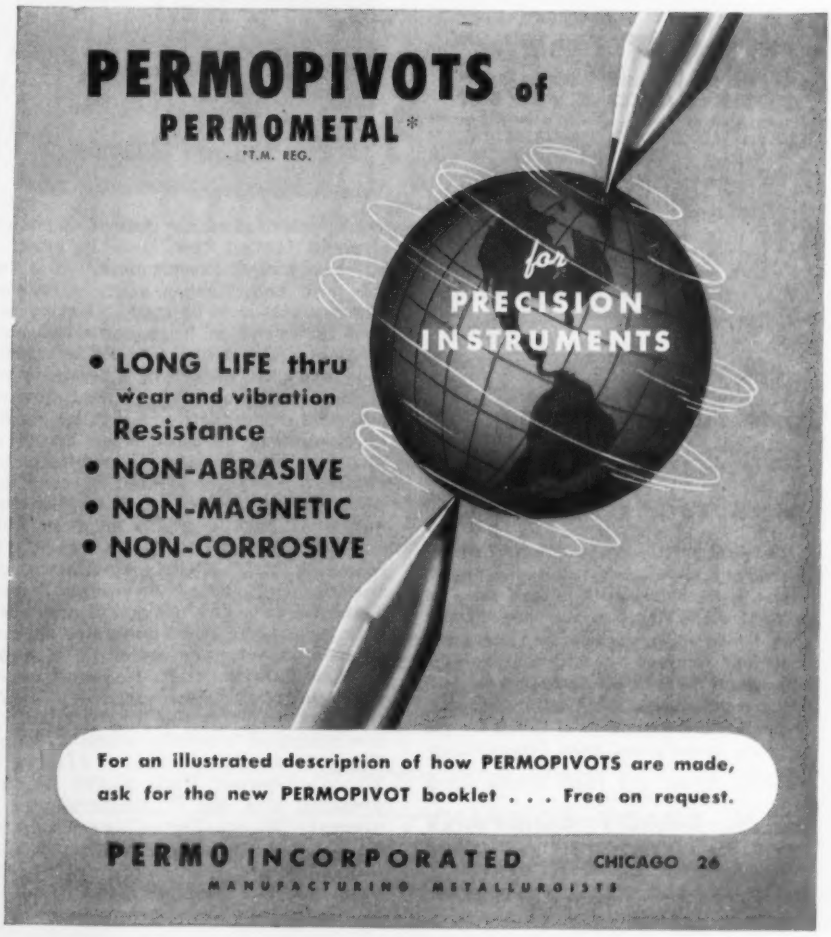
RAPID, ACCURATE RESPONSE TO ALL SPEED CHANGES

Originally designed to operate with an aircraft-type tachometer generator, the CF-3 can be used with any a-c generator possessing suitable characteristics, and is ideally suited for use with rotary presses, turbine generators, and other rotating equipment.

Highly dependable, the accuracy of this recorder is unaffected by lead length or variations in lead resistance, and the electrical principle on which it operates tends to provide greater accuracy than is obtainable in centrifugal or chronometric-type instruments. For further information, write for Bulletin GEA-4703, *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

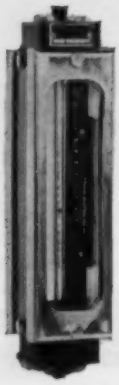
602-110

GENERAL ELECTRIC



The Full-View

ROTAMETER



reduces maintenance

The Full-View rotameter is an entirely new and advanced instrument, expressly designed to withstand hard use and to reduce maintenance costs. The end fittings and heavy side plates are assembled like a precision die by means of eight stainless steel dowel pins, that give automatic alignment and firm resistance to pipe line strain. Your greenest maintenance man can service this instrument because of the definite guidance to proper assembly provided by the dowel pins. With wages and materials skyrocketing, here is an instrument *whose final cost is low* because it can be quickly and simply maintained in good working order. For full information, write for Bulletin 20, Brooks Rotameter Company, Box A-5747, Lansdale, Pa.

BROOKS ROTAMETER CO.

LANSDALE, PA.

QUIK-LABELS

CODE CARD SYSTEM

Removable Self-Starter Strip exposes ends of Labels for you to peel!
DON'T PICK. USE SELF-STARTER STRIP TO PEEL LABELS.
FREE SAMPLES
DON'T PICK. USE SELF-STARTER STRIP TO PEEL LABELS.
1 PEEL
2 APPLY
3 IDENTIFY
LIKEWISE ON FLAT SURFACES
Patents Pending

QUIK-LABELS

Mark Your Wires Faster

QUIK-LABELS code Wires, Leads, Circuits, Relays, Parts, etc., faster and cheaper. • Pre-cut to exact size, QUIK-LABELS come on handy cards. • Ready to use, they stik-quik without moistening, replace slow and costly string tags, roll tapes, decals, stencils, metal tabs, etc. • Silicone plastic coated to resist dirt, grease, abrasion. • *Self Starter Strip automatically exposes ends of Labels for you to grasp instantly—no more finger-picking.

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W. H. BRADY COMPANY

Established 1914

Manufacturers of Self-Sticking Tape Products

804 N. 3rd Street, Milwaukee 3, Wisconsin

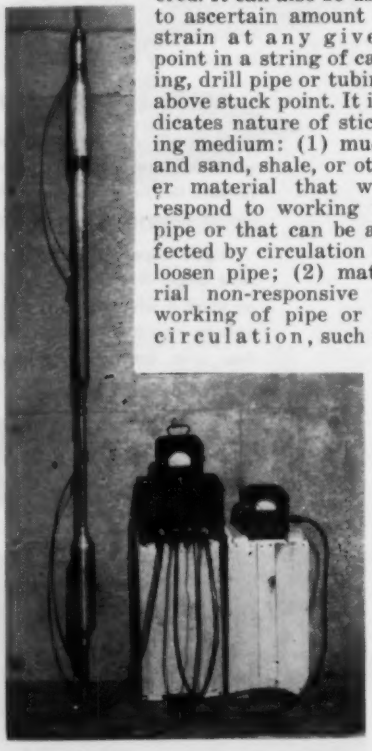
Factory—Chippewa Falls, Wisconsin

mfd.; (2) Plate r.f. by-pass capacitor 250 mmf.; (3) Plate load resistor 250,000 ohms ⅛ watt; (4) Grid resistor 500,000 ohms ⅛ watt. It requires only four soldered connections instead of usual eight or nine required with standard components.—*Centralab Div., Globe-Union Inc., 900 E. Keefe St., Milwaukee 1, Wis.*

Please mention number 744 when filling out card

Oil-well Stuck-pipe Locator

New "Magna-Tector" locates (often within 12") the point at which pipe is stuck in a well, or lowest point that it is free and from where it can be recovered. It can also be used to ascertain amount of strain at any given point in a string of casing, drill pipe or tubing above stuck point. It indicates nature of sticking medium: (1) muck and sand, shale, or other material that will respond to working of pipe or that can be affected by circulation to loosen pipe; (2) material non-responsive to working of pipe or to circulation, such as



hard-packed sand or cement. Primary element (called "tool") is in effect a 60" base-length extensometer: it is run into well and, when a point is reached where a test is to be made, electric current is turned on to energize two electromagnets, one at each end of "tool." Magnets cling to wall of pipe and serve as anchors. When pipe is pulled upward, magnets move farther apart by reason of elongation of pipe. Near center of "tool" an electric-gage transmitter sensitive to 0.001" is located in combination with a telescopic joint, so that elongation of base-length is read on indicating instruments at surface. To relocate "tool," electromagnets are deenergized by cutting off current, "tool" is moved to a new elevation and energizing current turned on again. Electrical components are sealed in a liquid silicone bath so that deep-well conditions will not impair accuracy. Effectiveness of design and construction was demonstrated recently when "Magna-Tector" was used successfully in World's Deepest Well: 15,000 lbs./in.^{2} pressure and 460°F. temperature. At present, "Magna-Tector" is not sold but is operated by maker's field engineers. —*McCullough Tool Co., 5820 S. Alameda St., Los Angeles 11, Calif.*

Please mention number 745 when filling out card

AMTHOR

TENSILE STRENGTH

TESTERS

for

PAPER
CORDAGE
RUBBER
LEATHER
WIRE
FLAT MATERIALS

•

PAPER FOLDING ENDURANCE TESTER
BURSTING TESTER
MICROMETERS (POCKET and DESK)
PAPER BASIS WEIGHT SCALES
CORDAGE SCALES
ALUMINUM FOIL SCALES
COMPUTING SCALES
RUBBER ABRASION TESTER
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TACHOMETERS INDICATING and RECORDING
MERCURY COLUMN GAUGES

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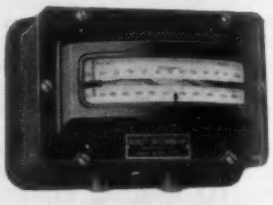
Wall-Type

INDICATOR PYROMETER

A PRODUCT OF 40 YEARS OF RESEARCH



Model W-1
Switchboard Indicator

Unskilled help may handle this direct-deflection instrument, which needs no manual adjustment. Designed for numerous ranges of temperature, both F. and C.

Write for descriptive Bulletin 400

Charles Engelhard, Inc.

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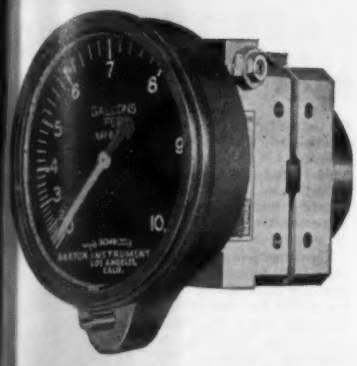
Differential Pressure INDICATOR



FOR RATE OF FLOW AND LIQUID LEVEL MEASUREMENTS

Suitable for Static Pressures Up to 3,000 P.S.I.

HAS RUPTURE-PROOF BELLOWS UNIT

An exclusive feature. Sensitive and accurate under high operating pressures. Withstands extreme over-ranging.

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Automatic ELECTRIC PRODUCTS

TIME SWITCHES

Ruggedly constructed *Automatic* Switches have visible dial in tamper proof compact cabinet . . . pure silver contacts . . . 2 to 24 "on" and "off" operations. For any load . . . for every installation an *Automatic* time switch or Interval Timer will deliver superior performance.

Synchronous or Manually Wound

FLASHERS

Automatic heavy duty, motor driven Flashers available in circuit arrangements for every conceivable effect. Pure silver contacts. Models for any load or purpose.

Alternates *Chasers* *Spellers*

RELAYS

Automatic manufactures a complete line of dependable relays for industrial, business machines, radio, electronic and many other uses . . . open, or can type with tube-base, plug-in features.

Consult our Engineering Department

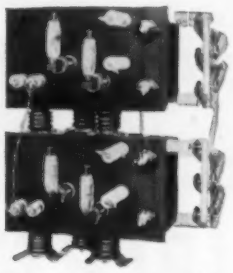
WRITE FOR SPECIFICATIONS AND INFORMATION TODAY

In Switches, Flashers and Relays where dependable performance is paramount, look for the "Diamond Seal for Diamond Quality".

WRITE TODAY!

AEMCO *Automatic Electric* MFG. CO.
STATE ST., MANKATO, MINNESOTA

NOW *small* RECTIFIERS *for* D-C Voltages up to 165 kv



This unit, 40 inches high, delivers 70 kv, d-c. Consists of two basic kenotron-tube rectifier units.

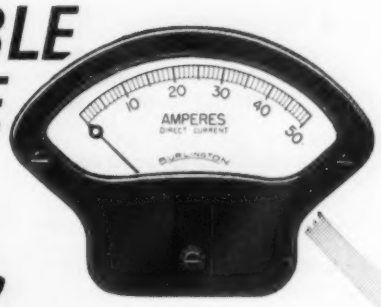
This small cascade-type rectifier for generating smooth high d-c voltages is suitable for laboratory and factory, for testing and as power supply. Features: long tube life and much lower cost of replacement tubes. Operates from 115-volt, 60-cycle power supply.

Basic unit is 35-kv, 30-ma (continuous) rectifier, 20-inches high. Up to five units can be stacked in series, giving d-c voltages up to 165-kv. *Apparatus Dept., General Electric Co., Schenectady 5, N.Y.*

401-78

GENERAL ELECTRIC

• RUGGED • DEPENDABLE • ACCURATE



Burlington

PANEL *INSTRUMENTS*

For utmost reliability—specify and depend upon Burlington Panel Instruments. They are designed, engineered and built to give satisfactory service even under most severe applications—and are fully guaranteed for one year against defects in material or workmanship.

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223 FOURTH STREET *BURLINGTON, IOWA*

MATCH UP with TRIPLETT Meters

5 BASIC MOVEMENTS IN SIZES FOR EVERY NEED

METER HIGHLIGHTS

- **FIVE BASIC MOVEMENTS**—Electrodynamometer, moving iron, moving coil, thermocouple and rectifier types.
- **RANGES**—All standard ranges for every major instrument need.
- **SIZES**—2", 3", 4", 5", 6" and 7".
- **STYLES AND FINISHES**—Round, rectangular, square and fan; wide flange, narrow flange, flush, projection or portable. Available in molded or metal case.
- **SPECIAL FEATURES TO ORDER**—Rear illumination, special dials and other features available on most models.

Triplett

ELECTRICAL INSTRUMENT CO.

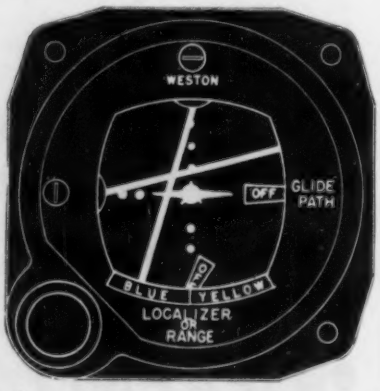
BLUFFTON, OHIO

AIRLINE PILOTS

Concluded from page 612

the presence of a satisfactory VHF range or localizer signal could not always be ascertained from the vertical needle. When in center position, this indicator shows that the airplane is on the desired flight path. It so happens, though, that the needle assumes the same position if certain failures occur in either ground or airborne equipment.

As a check against such a possibility, the airlines, CAA and the military agreed upon a new Flag Alarm type cross pointer (see sketch). The vertical and horizontal needles of the instrument operate and function in the same manner as those on the original cross pointer. The red "Off" flags become visible whenever there is no signal or insufficient signal to provide a reliable indication from either the vertical or horizontal needle. Ground transmitters are monitored so that failures automatically turn off the transmitter, thereby causing the flag to appear, warning the pilot of the failure of the facility to which he is tuned.



New navigation facilities usually mean new instruments for the aircraft, or a replacement of old instruments with new. For example, with the omnidirectional range, two instruments will be required: a radial or course selector and a radial converter indicator. Distance measuring equipment will require one new instrument in the flight deck —one which will indicate the distance from the aircraft to some specific point where the transmitted is located. Final design of this instrument must combine accuracy and ease of perception.

Many times the design of an instrument has been improved as a result of suggestions from pilots, mechanics or instrument maintenance men. When such suggestions have been proved worthy of action, they are passed on to the instrument manufacturer who in turn makes them available to the industry.

Back of all the developments in aircraft instrumentation, navigation and communication today is an effort to obtain standardization not only on a domestic, but on an international and military basis. Every organized activity by the various groups involved fits into a definite pattern of future planning for greater safety, greater efficiency and economy of operation.

PYRO THE SIMPLIFIED OPTICAL PYROME

SAVE TIME AN MONEY!

By using PYRO, a self-contained, DIRECT READING, sturdy unit made to stand rough use. It is absolutely accurate and dependable, and quickly pays for itself.

Unique construction enables operator to rapidly determine temperature even on minute spots, fast moving objects, or smallest stream; no correction charts, no accessories, no maintenance expense. Special "FOUNDRY TYPE" and "Universal TRIPLE RANGE" have, in addition to standard calibrated range, a red correction scale determining TRUE SPOUT and POURING TEMPERATURES of molten iron and steel when measured in the open.

Stock ranges 1400° F. to 9000° F.

Bulletins on PYRO Optical, Radiation, Surface and Immersion Pyrometers on request.

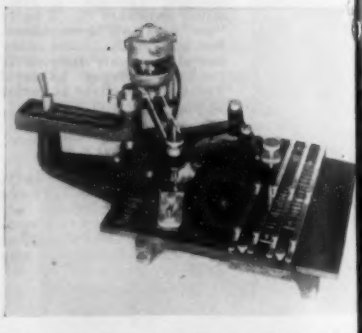
THE PYROMETER INSTRUMENT C

Plant & Lab

103-107 LAFAYETTE ST., NEW YORK, N.

In Canada, Sales and Repair Laboratory: Dominion Flow Meter Company Limited Toronto and Montreal

—MICO— ENGRAVER



For lettering panels of steel, alum num, brass, or bakelite, or for maki finished apparatus.

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JOURNAL of the Instrument Society of America

Editor, R. R. PROCTOR, 2213 Ridge Ave., Evanston, Ill.

Vol. 2 JULY 1947 No. 7

Editorial

...DON CONVENTION FEATURES ...RS ON AUTOMATIC CONTROL

...n May 19-22, 1947, the Institution ... Electrical Engineers of England ...d a convention in London on the sub... "Automatic Regulators and Servo ...chanisms." I.S.A. Vice-President J. ...McMahon, who is also chairman of ... International Liaison Committee, ... in London at the time and at...ded some of the sessions of this con...tion, and he reports that some very ...ellent papers o nthe subject of Au...atic Control were presented.

...n line with the aims of the I.S.A. ...blications Committee to present to ... members the most interesting and ...ormative material it is possible to ...ain, Mr. McMahon (although not a ...mber of this committee) secured a ...py of each of the fifteen papers pre...nted; at the same time he started ...oceedings to obtain permission from ... Secretary of the Institution, Mr. W. ... Brasher, to abstract, reprint, pub...h or otherwise distribute to I.S.A. ...mbers any of these papers which, in ... opinion of the Publications Com...ittee, are truly contributions to the ...t and are deemed worthy of so dis...buting.

...Anticipating the early receipt of the ...quested formal permission from Lon..., the Publications Committee, under ... chairmanship of Dr. Ralph H. ...unch of St. Louis, has appointed a ...b-committee to review the papers ...ought back by Mr. McMahon. This ...b-committee is headed by Al Sperry ... Chicago (Past-President of I.S.A. ...d the subject of one of our "Who's ...ho" articles in this issue). Al is a ...tionally known authority on Auto...atic Control and Servo Mechanisms, ...d no better man could have been ...osen for the job of determining ...hether any of the subject papers are ...orthy of presentation to the I.S.A. ...embership.

...This committee is at work now, but ... will be some time before the job is ...mpleted. Brief summaries of all the ...apers will be found elsewhere in this ...sue, and one can see from a quick ...lance through them that it will be a ...remendous job just to separate the ...wheat from the chaff." Some of the ...apers may be of little interest to ...S.A. members, or may present noth...ng new whatsoever, and these will be ...iscarded. Some may be of interest to ... few, or contain some new material, ...fficient to warrant their presentation ...n abstract form. Others may be vitally ...ew, representing real contributions in ...he field and containing material of ...reat interest to many I.S.A. members, ...nd it is our hope (speaking for the ...Publications Committee) that these ...apers can be reprinted in full for the benefit of the members, either in the JOURNAL or through some other channel to be determined by the Publications Committee.

(We are informed that a continuing paper shortage may preclude the use of the JOURNAL as the forwarding medium for these papers. However, if any of the papers are basic enough to deserve reprinting in full, they will be just as valuable later on when the paper shortage eases and we *can* print them.)

If anyone should wonder why this is being brought up at all when we can give no assurance that any of the papers *will* be published, or even considered worthy of publication in the JOURNAL, it is mentioned for two reasons: (1) as an example of the type of cooperation which is possible between separate technical societies with common interests, and (2) as an example of the continuous efforts being put forth by the Publications Committee, and by Ye Editor as the "mouthpiece" of the committee, to make the JOURNAL what the members would like it to be—a *useful* publication. (Most of our readers probably do not appreciate the difficulties under which we are still operating in trying to build up the JOURNAL and otherwise get a comprehensive publications program under way.)

So whether or not any of these British papers will appear in the JOURNAL remains to be seen. It is our hope that they may. In any event, the Society owes a vote of thanks to J. B. McMahon for having the interests of the I.S.A. members at heart while on his recent business trip to Europe, both in cementing the friendly relationships between the Institution of Electrical Engineers and the Instrument Society of America, and in securing copies of these papers (and permission to republish them) and presenting them to the JOURNAL. Now that we have first chance at publishing them in this country, we hope to be able to take advantage of the opportunity, and likewise to be able to reciprocate in kind at some time in the future. More on this later.

—R. R. PROCTOR

INSTRUMENTATION AND THE FUTURE

A Guest Editoral
by W. F. Hughes
(Delegate, Aruba Section)

The members of the Instrument Society of America are fortunate in belonging to a group that is interested and able to guarantee employment. This statement may seem hard to believe, but analysis will prove its truth.

Since the members of our Society are affiliated because of a common interest in Instrumentation, we are the natural salesmen for our own positions. The burden is evenly divided. The Designer must keep abreast of the need for new equipment and in many cases step out ahead with something better than the Consumer has considered. The Salesmen, the Sales Engineers and the Instrument Engineers must sell and plan installations to get the most out of the equipment. The Maintenance Men not only have the job of making instruments work efficiently with guaranteed satisfaction, but are in a position to help sell new and better equipment through their constant contacts with the Users. The ultimate aim, then, is to provide and maintain instruments that make work easier for the User, improve quality and quantity of production, and eliminate needless manual operations.

One may say that our aim is to make instrument users come to depend upon the results of our efforts to such an extent that we are a constant necessity to industry.

Although we may work alone and achieve some degree of success in reaching this end, free and more frequent exchange of ideas throughout our organization will make the job easier and more interesting. LET'S STEP OUT WITH THE NEW IDEAS and bat them around until either as individuals or as a group we have something to offer to advance our profession and hence further stabilize employment.

—WFH

Automatic Regulators and Servo-Mechanisms

Summaries of Papers Presented at Institution of Electrical Engineers Convention in London, England, May 19-22, 1947.

"Fundamental Principles of Automatic Regulators and Servo Mechanisms" By A. L. Whiteley, D.Sc., British Thomas-Houston Co. Ltd.

The elementary theory of closed-loop systems is considered; such systems are known as servo mechanisms, automatic regulators, or process controllers. Though the actual forms and applications are widely different, some common principles can be established; in particular the tendency towards self-oscillation or "hunting" is likely to be encountered in any type of closed-loop automatic controller. The reasons for this form of instability are examined in the paper, and an elementary approach to the stabilizing problem is given. Electrical systems are dealt with mainly, but the ap-

proach in the case or analogous dynamical systems is briefly indicated.
The theoretical treatment given is necessarily elementary, and is thus confined to linear systems. Transient response obtained by operational methods is considered; also harmonic response, which lends itself to graphical methods of studying system performance.

"Elements of Position Control" By Prof. K. A. Hayes, O.B.E., B.Sc. (Eng.), Military College of Science.
The paper offers a general descriptive survey of position control, including the characteristics of the usual input signal and load and their effects on performance. The basic principles of automatic control are applied to unmonitored and monitored position-control systems.
Displacement-displacement servo systems are dealt with in some detail, the emphasis being on electric-non-thermionic amplifiers, and electric servo motors. The performance of these systems is discussed without any analysis, but the results of analysis are used for the recommended performance.

"The Use of Servos in the Army During the Past War" By Brigadier E. J. H. Douch, O.B.E., Ministry of Supply.
The paper reviews the principal applications of servo mechanisms to Army weapons during the past war, giving in each case a general description of the particular system employed, and outlining the main historical and design factors governing its adoption. Features of design of special interest are noted. It is not claimed that the number of examples given is exhaustive, but it is representative of the field covered in relation to Army weapons.

"The Nature of the Operator's Response in Manual Control, and its Implications for Controller Design" By Prof. A. Tustin, M.Sc., University of Birmingham.
This paper gives a brief account of a series of measurements of the movement of the controller handle and of the error of aim under conditions simulating the laying of a gun on a moving target by manually-controlled power operation.
The results are analysed with the object of obtaining the "operator's response," i.e. the relationship between the movement made by the operator's hand and the error and its variation as seen by the eye.
It is found that the response relationship is non-linear, but the relationship may to a useful extent be approximated by a "nearest linear law" namely that the speed of handle movement is dependent upon both the error and the rate of change of error, subject to a time delay which corresponds to that known to be involved in nerve transmission. The actual movement is found to differ from this relationship, both in being intermittent or jerky and also in being subject to apparently haphazard variations.
A project for further investigation is outlined by which the difficulties in more detailed analysis may be overcome.
On the basis of the results so far obtained it is shown that an explanation is provided for some of the outstanding phenomena observed in the laying of guns and in other cases of manual control of power-driven apparatus, and it is shown that there is an upper limit to the accuracy of control obtainable.
Finally, the paper shows how the error incurred in tracking a target is fundamentally related to and depends upon the time delay which occurs between the stimulus received by the eye and the resulting muscular response, and gives comparative values for the theoretical limit of accuracy obtainable with controllers having various types of response characteristics, as a function of this delay time, for an otherwise ideal operation.
The lines along which an improvement of performance may be sought are discussed in the light of these limits and the other phenomena observed.

"Some Servo Mechanisms Used by the Royal Navy" By Commander (E) J. O. H. Gairdner, O.B.E., A.M.I. Mech. E., R.N. Naval Ordnance Department, Admiralty.
In naval gunnery, especially in anti-aircraft systems, it is necessary for the gun to be kept constantly laid upon the target, regardless of the ship's movements, with a high degree of accuracy. The paper discusses the implications of this requirement in terms of the angular movements to be imparted to a normal 2-axis gun, and shows the necessity for complete automatic power operation of the gun from the calculating position. It also shows that automatic operation is likewise necessary in every link of the complex system that constitutes a modern fire-control arrangement. From this introduction the paper describes the history of early efforts at automatic control, leading up to methods used in H. M. Ships during the war. The relative merits of electricity and hydraulics for these large position-control servos are discussed, and the difficulties of adapting the earlier designs of mountings for automatic control are presented.
The paper ends with a summary of the somewhat stringent requirements which naval servos must satisfy.

"Data-Transmission Systems" By J. Bell, M.Sc., Muirhead and Co., Ltd.
The paper deals with the methods employed for the transmission of data which have been used in the Fighting Services up to the present day. An historical review is made of the main types of instruments used over the last 40 years, particularly for Naval purposes. The development of the present types of data transmission—in particular the magslip—is dealt with more fully, and references are made to parallel developments in this and other countries.
Various applications are described, giving the methods of application and limitations of use of the various types of element.
A number of photographs showing typical magslip elements are included, and an abbreviated list of types of magslips and some performance figures are given in an Appendix.

"Naval Applications of Electrical Remote-Positional Controllers" By W. E. C. Lampert, Assistant Director of Electrical Engineering, Admiralty.
A survey is made in this paper of some of the applications in the Royal Navy of all-electric servo mechanisms for armament control purposes.
The need for the greatest possible measure of automatic operation in fire-control prediction, and in the pointing of the guns in accordance with this prediction, in order to combat high-speed aircraft and to make the fullest possible use of the continuously up-to-date location of the target by radar, led to the introduction of the servo and remote power-control systems described.
By far the greater part of the systems referred to in the paper are therefore the results of development and application to specific projects over the past ten years. Brief reference is, however, made in the first part of the paper to some earlier forms of servo mechanisms of the contact-operated type used in the Navy, since this is of interest as a background to the later and more modern types of continuously operating servos, which have largely superseded them.
This is followed by a description of some applications of high-performance servos of small or medium powers. These are mostly of the type using a split-field d.c. motor in which the armature of the motor is supplied direct from the d.c. supply through a series resistance (to limit the current at stand-still) and the motor fields from a thermionic amplifier under the control of the servo transmission.
Finally a description is given of remote power-control applications of large power in which the initial amplification is by thermionic amplifier, but in which further power amplification is obtained from rotating machines (Metadyne and Ward Leonard feeding the armatures of separately excited d.c. motors which drive the load.
A general reference only has been made to the M-type and magslip electrical data transmission systems used for the servo and remote power-control schemes described, since information concerning these is given in the paper on "Data Transmissions" by Mr. J. Bell.

"The Use of Servo Mechanisms in Aircraft" By Prof. A. A. Hall, M.A., Imperial College of Science and Technology.
In each field in which servo mechanisms have been applied in aircraft, different designers have used different mechanisms to achieve the same result, and each particular type of mechanism has been used for different applications. Therefore, this survey can show no more than a few cross-sections. Section 1 gives a brief account of the conditions which a servo system will encounter in the air; Section 2 is an account of typical applications to which servo systems are put in the air; and Section 3 is an account of some trends in development, as illustrated by a few designs which have been used.

"Theoretical Foundations of Process Control" By G. H. Farrington, B.Sc., Chief Engineer, Ilford, Ltd.
The paper surveys the theoretical foundations which underlie the behavior of automatic process control. The general nature of control systems is described and, for analytical purposes, the control action and the plant response are taken separately. Consideration is given to the plant characteristics as determining response to potential correction and mention is made of the analogies with electric circuits which can be useful employed in this connection. Basic control actions are described and a fundamental distinction is drawn between action and control. The questions of stability and damping are examined with the help of vector diagrams and polar curves. Stress is laid on the limitations on damping which are imposed by the nature of the plant characteristic. Theoretical examples are given of the effect of various methods of control on a postulated plant in face of load and set-point changes. Attention is drawn to the approximations involved in the practical generation of integral and derivative control action, with particular reference to the control setting restrictions imposed by present methods of providing combined proportional, integral and derivative control. Finally, brief consideration is given to the possibilities of applying theoretical analysis to actual process control.

"Automatic Voltage Control of Generators" By C. Stewart, British Thomson-Houston Co., Ltd.
This paper does not attempt to describe particular makes of automatic voltage regulators, about which so much literature is already available. Instead, after a general classification of regulators, an attempt is made to describe the governing factors in regulator design, and the various ways and means which are adopted to achieve suitable automatic control.

"Amplidyne Regulating Systems" By E. Adkins, M.A., British Thomson-Houston Co., Ltd.
The amplidyne is a cross-field-excited d.c. generator, in which the field input is much smaller than that of a normal generator. Because of this property it can be used as an automatic regulator for a wide variety of industrial equipments. In such an equipment, the amplidyne is generally used as an exciter for a larger machine or combination of machines, such as a.c. or d.c. generators or motors, or intermediate exciters. In this way a large output can be controlled from the amplidyne field current. In order to obtain automatic regulation of any quantity the quantity is matched against a constant reference, and the difference is used to excite the amplidyne so as to correct any change, thus forming a closed-cycle control

tem. A high accuracy of regulation under steady conditions can easily be achieved in this way.

Under transient conditions, the behavior of the equipment is a matter of changes relative to the steady state, and can be investigated by means of an equivalent system diagram from which all steady voltages are omitted. A typical equivalent system consists of a chain of amplifying stages with a feedback circuit connecting the output of the last stage to the input of the first stage. With the aid of this equivalent diagram the nature of any oscillations which may occur can be investigated. This method of attack is of general application in relation to the whole system and to each component, as well as the effect of additional apparatus such as anti-hunt transformers, and ballast resistors.

"Automatic Control Applied to Modern High-Pressure Boilers" By Ll. Young, — Hailey Meters and Controls, Ltd.

The developments in boiler design necessitated by the employment of high steam pressure and temperature have increased the sensitivity of the boiler unit to variations in firing rate. As a result the duties of the operator have become more onerous, and reliance on the skill of the individual rendered the performance of the plant dependent on the human element.

Recognition of the limitations imposed on plant efficiency by the intervention of the boiler operator has led to many plants being equipped with automatic devices to execute routine readjustments in fuel and air supply and feed-water flow.

The paper describes an air-operated system of automatic boiler control, though the principles stated apply equally to systems using other types of motive power.

The equipment described has proved to be reliable in operation and apart from the improved technical performance over manual control, has increased the overall efficiency of boiler plants so equipped.

Apart from the automatic control of stoker and pulverized-fuel-fired boilers, devices for the control of steam temperature, water level and feed-pump protection are also described.

"Automatic Control in the Chemical Industry" By J. W. Broadhurst, T. C. Broderick, A. W. Foster, and G. E. Wheeldon, Imperial Chemical Industries, Ltd.

An attempt is made to summarize the present position of automatic control in the chemical industry.

After discussing the advantages to be gained by automatic control, it is shown that at present the chief difficulty in the chemical industry lies in the measuring element. These difficulties are discussed, and typical examples are given.

A resume is given of basic types of control equipment at present in use in the chemical industry. These are, in the main, pneumatic or hydraulically operated; the reasons for this are discussed.

The controlled process is briefly considered, and the lines of possible future development are discussed, with particular reference to process analysis and the design of complete electrical control systems capable of working under chemical plant conditions.

"Some Industrial Electronic Servo And Regular Systems" By E. W. Forster, B.Sc., and L. C. Ludbrook, B. Eng., British Thomson-Houston Co., Ltd.

Experience of electronic servos in industry since 1932, and under arduous military conditions since 1939, indicates that correctly engineered equipments will give at least ten years' service under heavy industrial conditions, with maintenance confined to occasional valve replacements and routine attention to auxiliary contacts. Failures of the latest high-quality components will be statistically insignificant up to fifteen years' life.

Transient and steady-state errors of linear continuous-control servos can readily be predicted, and the use of electronic amplifiers permits very close approach to the known fundamental limits. Non-linearity seldom improves accuracy in the normal range, but is necessary for good recovery from disturbances exceeding this range, and can readily be introduced at the required signal level in electronic amplifiers. Electronic position-control servos, highly developed for military applications, appear essential to future nuclear-power plants and are immediately applicable to the mechanical handling problems of heavy industry.

Electronic voltage regulators of the thyratron type have been used since 1935 for controlling the voltage of generators, not only for special testing installations requiring voltage regulation to within $\pm 0.1\%$, but also for controlling the voltage of large alternators in power stations.

Electronic speed regulators are used for controlling the speeds of d.c. motors, the method of control being by variation of shunt field-current, armature voltage, or a combination of both. Motors of 4000 h.p. are being controlled by acting on the shunt field of the generator supplying armature power to the motor.

Speed control of a.c. commutator motors of the Schrage type is achieved by the automatic operation of the brush gear-shifting motor.

These points are illustrated by description of typical industrial applications of position control servos and automatic regulators for current, voltage and speed.

"Electronic Servo Simulators" by Prof. F. C. Williams, O.B.E., D.Sc., Department of Electrotechnics, Manchester University and F. J. U. Ritson, B.Sc., Turner and Newall Research Fellow, King's College, Newcastle.

The paper presents an outline of a method which will allow automatic control systems to be studied experimentally by means of an electronic apparatus called a "simulator," which is constructed so as to have the same characteristic equation as the control system.

This apparatus may be used to predict the response of the control system to the usual standard input signals such as step-function changes in the value of the input quantity or of its derivative or to the more complex input signals encountered in actual use. The method is considered to be valuable in cases where these responses are difficult to calculate because of the complexity of the control system or because it contains non-linear elements.

Simulators may be broadly classified into two categories, first "slow" simulators in which the time scale is such that any transients occur slowly enough to be recorded by an operator reading a meter or on a recording instrument; and secondly "fast" simulators in which transients are recorded with an oscillograph. Often this type is operated at a recurrence frequency of, say 50 c/s and is then called a "repetitive" simulator.

A simulator for an r.p.c. servo mechanism stabilized by "phase advance" is discussed in detail to illustrate the methods of design and results obtained with the apparatus are compared with those calculated from the characteristic equation. Electrical computation circuits which have been found useful are summarized in a table. It is shown how the apparatus can be modified for the study of servos which are stabilized by feedback methods. Two cases where the control system contains non-linear elements have been studied; first the case where the servo-motor torque is limited, and secondly where backlash exists in the gearing between servo motor and reset. Curves showing the effect of various amounts of torque limitation and backlash are given.

Finally repetitive simulators are discussed briefly and circuits for producing the input signals and oscillograph time-base waveforms are described.

Official News

To All Section Secretaries

Many Sections elect new officers in May or June, and a number of announcements of these changes have already reached this office. To the previously published list of Section Delegates, Secretaries and JOURNAL Correspondents, the following additions and/or changes should be made. It is intended that a complete up-to-date list will be published in September or October. If any changes have been made in your Section personnel, please advise the Editor of the JOURNAL as soon as possible so that the new list will be correct.

By Sections, these changes are now in effect:

BALTIMORE: New Secretary and Treasurer—Felix Cox, Bethlehem Steel Co., Sparrows Point, Md.

CHICAGO: New JOURNAL Correspondent—Miss Sylva Mae Dushkes, Askania Regulator Co., Chicago, Ill.

CLEVELAND: New Secretary — Clark Joy, 4569 W. 220 St., Cleveland 16, Ohio. New JOURNAL Correspondent—L. H. Waldrip, 3929 Strandhill Road, Cleveland 20, Ohio.

CUMBERLAND: New JOURNAL Correspondent—John S. Kelly, 322 Cumberland St., Cumberland, Md.

DETROIT: New Secretary—Robert W. Gardner (Ford Motor Co.), Instrument Society of America, 100 Farnsworth Ave., Detroit 2, Mich.; New Delegate—J. Richardson (Brown Instrument Co.), 415 Brainard St., Detroit, Mich.

NEW JERSEY: New JOURNAL Correspondent—H. M. McCarthy, Standard Oil Development Co., P. O. Box 37, Elizabeth, N. J.

TENNESSEE: New Secretary—L. W. Thayer, 1229 Bristol Highway, Kingsport, Tenn.; New Delegate—J. T. Elder, 318 W. Ravine Rd., Kingsport, Tenn.; New JOURNAL Correspondent—J. D. Barnes, 1636 Pineola Ave., Kingsport, Tenn.

Abstract of Minutes of Cleveland Meeting of Board of Directors

The Board of Directors of the Instrument Society of America convened at 11 a.m. in the Aviation Room of the Carter Hotel, Cleveland, Ohio, April 25, 1947, President Fairchild presiding. The following Sections were represented:

SECTION	VOTES	DELEGATE
Aruba	26	Harvey Lee (proxy)
Central Indiana	65	Harvy Rockwell
Charleston	112	Charles Holtz
Chicago	231	Earl Rieger
Cleveland	105	Harvey Lee
Cumberland	27	A. H. Shafer (proxy)
Detroit	82	H. H. Barnum
Kansas City	36	O. L. Boutros
Louisville	41	E. H. C. Brown
New Jersey	133	George Feeley
New York	122	Ralph Batcher
Oak Ridge	67	Charles Holtz (proxy)
Philadelphia	242	M. H. White
Pittsburgh	151	A. H. Shafer
St. Louis	68	R. H. Munch
South Bend	21	J. Buck
Washington	121	R. Goetzenberger
Wayne County	40	Wm. Baker

Total Sections 18; total membership represented 1690.

Executive Committee: C. O. Fairchild, President; C. F. Kayan, 1st Vice-President; H. H. Barnum, R. H. Munch, Vice-Presidents; H. E. Ferguson, Treasurer; Richard Rimbach, Executive Secretary; A. F. Sperry, Past-President. Absent: J. B. McMahon, Vice-President.

Guests: D. J. Angus, Indianapolis, S. Rudolph, Chicago, G. Kelsey, New York—members of Instrument Manufacturers' Advisory Committee; G. E. Gilliam, South Bend; C. A. Mabey, New York; Ed Grace, Philadelphia; Paul Exline, Pittsburgh; Sam Bousky, Cleveland; A. Hejduk, Cleveland; R. R. Proctor, Chicago.

The following items were considered by the Board:

1. Minutes of last meeting, mimeographed and distributed previously. Reading dispensed with, but accepted as distributed.

2. Report of Committee on Committees, W. A. Wildhack, chairman. Presented by Mr. Goetzenberger in absence of Mr. Wildhack. Report accepted, following which a motion was passed that the Committee on Committees as such be disbanded and a new standing committee known as the "Committee on Rules and Procedures" be established. This committee "shall formulate, coordinate, maintain records of, and periodically review such rules and procedures as are deemed necessary or desirable and are promulgated or approved by the Board of Directors for the guidance of the officers and members of the Society, in the conduct of the Society activities and in facilitating fruitful contacts and cooperation among themselves and with other technical societies. Rules adopted by any committee for the conduct of its own activities, or directives for its sub-committees shall be referred concurrently to the Committee on Rules and Procedures for comment and recommendations, and to the Board of Directors for approval. It shall initiate and receive suggestions for the establishment of new standing committees and shall recommend to the Board of Directors and the Constitution Committee such changes in the By-Laws as may be necessary to provide for the committee required to carry on the proper and desirable activities of the Society."

3. Report of Constitution Committee. None, due to illness of Harry Moore, chairman.

4. Report of Educational Committee, Dr. B. R. Teare, chairman. Complete report submitted but not read, and accepted.

5. Report of Employment Committee, C. F. Goldcamp, chairman. Report accepted with thanks. (Summary of this report published in May JOURNAL, page 471).

6. Report of Finance Committee, A. H. Shafer, chairman. Report accepted, and the following actions taken on recommendations in the report:

a. Motion that the Executive Committee be given authority to approve the accounting system as set up by the Treasurer. Passed.

b. Motion that all physical and business arrangements in connection with National meetings be placed under the authority of the Executive Secretary. Passed.

c. Motion to employ an additional assistant in the Executive Secretary's office at a maximum rate of $2200 per year. Passed.

d. Motion to set aside $400 per year for legal advice. Passed.

e. Motion to place $5000 in Government bonds as a sinking and reserve fund during 1947. Passed.

f. Motion to put aside $500 for equipment and its depreciation. Passed.

g. Recommendation that $3000 be placed in the hands of the Recommended Practices Committee. Discussion postponed until after the report of that committee.

7. Report of Meetings Committee, A. F. Sperry, chairman. Report, covering the arrangements made with the Stevens and Congress Hotels in Chicago for the 1947 Conference and Exhibit, accepted with thanks.

8. Report of Membership Committee, R. Rimbach, chairman. Report, listing increase of Sections and membership since January, 1946, accepted as read.

9. Report of Emblem Sub-Committee, Philip Ewald, chairman. Report read by Mr. Rimbach in absence of Mr. Ewald. Emblem design was exhibited and motion made and passed to accept same and start necessary proceedings to procure them in quantities. (This report, together with design of emblem, was published in May JOURNAL, page 471.)

10. Report of News Sections Committee, J. B. McMahon, chairman. Read by Mr. Barnum in absence of Mr. McMahon. Report accepted. (The gist of the recommendations in this report was incorporated in the editorial in the June JOURNAL.)

11. Motion to officially thank the Cleveland Section for its fine job of arranging for the subject meeting was then passed.

12. Report of Nominating Committee, Earl C. Rieger, chairman. Mr. Rieger reported on the present status of activities in preparing a slate of officers for consideration at the annual meeting in September. Report accepted with thanks.

13. Report of Publications Committee, R. H. Munch, chairman. (To be abstracted and published shortly.) Report accepted as read with thanks.

14. With the Board's permission, the report of the Public Relations Committee, C. O. Fairchild, chairman, was referred back (without asking for acceptance) to the Committee on Committees and the Constitution Committee for action on the suggested change of name to the Coordinating Committee.

15. Report of the Recommended Practices Committee, F. H. Trapnell, chairman. Following acceptance of this report, motion was made and passed that $3000 be set up for the issuance to every member of a binder suitably inscribed with the I.S.A. emblem, to contain the releases of the Recommended Practices Committee and whatever other material the Publications Committee sees fit to publish in such form. (The approval of such a binder was reported in the May JOURNAL, page 471.) (The report of the Recommended Practices Committee was abstracted and combined with correspondence from the chairman, Mr. Thapnell, and published in the June JOURNAL.)

16. Report of Research Committee, R. H. Muller, chairman. None.

17. Report of special Committee on Expenses of Delegates, A. F. Sperry, chairman. The report brought out that the Society is not yet financially able to pay the expenses of Delegates to National Meetings. Following considerable discussion, it was moved that the Society should not attempt to pay such expenses. The motion was seconded, but further discussion indicated that it would be advisable for a protem ways and means committee to further investigate the situation before definite action was taken. It was decided that the question should be brought up at the annual meeting in September; therefore a motion to table the original motion was made, seconded and passed.

The meeting was then adjourned.

I.S.A. Employment Service

INSTRUMENT SALESMEN by steam specialties sales organization. Will be required to handle industrial process problems for pressure reducing valves, boilers, various types of controls, pumps and steam specialties. Must have previous experience and technical education of an engineering nature. Two territories open, southeast portion of Ohio and northwest portion of Ohio. Commission with drawing account. Applicants must own car. Box 62.

• • •

INSTRUMENT TECHNICIANS by Tennessee Valley Authority. Must have experience in repair and calibration of delicate electrical instruments and a thorough knowledge of electrical measurements. Positions classified as Electrical Engineer I with entrance salary of $2770 per annum based on 40 hour work week schedule with opportunity for within-grade increases and promotion. Location Chattanooga, Tenn. Box 63.

• • •

ZONE MANAGER for leading automatic control manufacturer. Must be familiar with instrumentation in chemical and other industries in order to work with representatives on East Coast. To be located preferably between Baltimore and New York. Box 64.

• • •

INSTRUMENT MECHANICS thoroughly familiar with and experienced in oil refinery instrument service and maintenance. Rate $1.[illegible] per hour. Location Missouri. Box 65.

• • •

ELECTRICAL ENGINEERS (two) by manufacturer of rocket propelled engines for design and development of electronic equipment involving pulsing, time constants, amplifier, power supply, circuits. Must be experienced with standard type of industrial instrumentation. Bourdon tube gages, thermocouples etc. and must be able to setup, take data and calibrate complicated electronic equipment. Should be able to build mechanical devices and operate, drill press, etc. Location New Jersey. Box 66.

• • •

INSTRUMENT ENGINEER by large manufacturer of control instruments for design and development of control instrumentation. Engineering degree and previous experience required. Must be thoroughly familiar with control instruments. Box 67.

"Do you mean to stand there and tell me that you can't have these things back on the job in three hours???!!"

Editor's Notes

Conference Schedule Arranged

At a meeting of the Chicago Convention Committee on June 6, 1947, Chairman A. F. Sperry presiding, many of the details were ironed out in the plans for the 1947 Conference and Exhibit to be held in Chicago this coming September 8-12. Barring unforeseen upsets, the seven technical sessions, plus one demonstration session, and the three educational sessions are as previously reported in these columns. The complete schedule of events, as it now stands, is shown in the timetable elsewhere in this issue.

Mr. Sperry reported that most of the technical chairmen for the various sessions had already been appointed, and Chairman Swarr of the Plant Trips sub-Committee reported that two plant trips had already been arranged. The first is a trip through the Standard Oil Refinery at Whiting. This trip is limited to the first 100 persons who register for the trip. The second is a trip through the South Works of the Carnegie-Illinois Steel Corporation, where the blast furnaces, open hearth, and rolling mills will be seen. A third trip through the Edison Meter Testing Laboratories and the Throop Street generating plant is being arranged. All of these are scheduled for Friday afternoon, Sept. 12.

The Stevens Hotel on Michigan Avenue, Chicago, where the 1947 Conference and Exhibit will be held, September 8th-12th.

Reports from other sub-committee chairmen present indicated that all committees are now active, and that everything is "now under control". Everyone attending the Conference can be assured of a well-planned and smoothly functioning affair, and the Society's thanks are hereby extended to the many committee chairmen and members whose efforts are and have been directed toward this end.

2. "Better Products at Less Cost"

This hopeful phrase is the keynote of the exhibit (as well as for the program of papers and the educational courses) at the Second Annual Instrument Conference and Exhibit to be held at the Stevens Hotel in Chicago in September.

The first general Bulletin announcing the Conference made its appearance in May. Cy Goldcamp and Macolm Lovejoy did a nice job on it, listing the tentative program of papers and an almost complete list of the exhibitors. Mentioned also in the Bulletin were a couple of little items which may have been overlooked, and which will bear repeating here:

(a) For the convenience of members and their guests arriving early, but unable to immediately obtain the use of their hotel accommodations, the Society is providing rooms near the exhibit hall which will be available during the morning hours. You are most cordially invited to make use of these rooms to freshen up after your trip.

(b) A message center will be maintained by the Society during the Conference in the Office immediately outside the Exhibition Hall. Lost and found service, message service and general information service will be handled here. Everyone is invited to make use of these services.

To us, it's remarkable how much a couple of little things like this contribute to the overall success of a convention. But it was proven last year in Pittsburgh—the message center, especially, was one of the busiest spots in the hotel!

Last but not least in this review of the Bulletin, we herewith "plug" another punch-line—*make your hotel reservations early.* This cannot be emphasized too strongly, as the room situation in Chicago is critical. Complete your plans now for your visit to the Chicago Conference, and get your hotel reservations made as soon as possible. See you at the Stevens.

3. The Needle Points to—

Aruba, Cleveland, Detroit, Oak Ridge and Southern Michigan — for generally interesting reports;

New Jersey—in a class by itself from Ye Editor's standpoint, requiring absolutely no editing, and the more remarkable in view of the fact that it was written by a newcomer, the newly appointed Correspondent, H. M. McCarthy. Let's have more like it, Mr. M.

R. R. Proctor

General News

Government Agencies to Exhibit at Instrument Show

Word has been received from the Office of the Chief of Ordnance, U. S. Army, that Army Ordnance will exhibit at the Second Annual Instrument Conference and Exhibit at the Stevens Hotel, Chicago, September 8-12, 1947.

The Ordnance Department will feature the latest electronic anti-aircraft computer. The demonstrator to be shown will have transparent side plates so that mechanisms can be seen. In addition to the computer, several special optical instruments and a rocket control will be exhibited.

Other Government Departments which are preparing exhibits are the National Bureau of Standards, the Naval Ordnance Laboratory and the U. S. Weather Bureau.

1947 Conference Schedule

With Chairman Al Sperry of the National Meetings Committee presiding, a meeting of the Chicago Convention Committee was held on June 6, 1947, at which time the tentative Conference schedule was approved as follows:

Barring unexpected developments, this schedule for the week of September 8 to 12 will be considered final when the official program goes to press. The subjects and speakers scheduled for the various papers sessions were announced in the June issue of the JOURNAL, as well as in the BULLETIN sent out in May. Final assignment of the speakers to particular sessions will be done shortly, and the complete program published as soon as it is available.

Section News

ARUBA

The eleventh meeting at the Aruba Section was held on the evening of June 3. The most interesting part of the business meeting was the report by our National Delegate, Bill Hughes. He stated that he had received a seven-page letter from Harvey Lee of the Cleveland Section who voted our proxy at the April Meeting of the Board of Directors in Cleveland. The letter covered the meeting very comprehensively and was packed full of information of great interest to our members. Bill also reported on the activities of the Project Committee, of which he is chairman, and then introduced the speaker of the evening, Paul E. Jensen, head of the Aruba Refinery Instrument Department.

Paul's talk was "Where is Instrumentation Headed?" He started off by saying that he was going to make some flat-footed statements since this was a broad subject and he was mainly interested in hearing the group put forth their opinions and develop a discussion. He got the desired results!

His talk covered the highlights of his 17 years' experience in Aruba. In the early days he was one of the members of the original Instrument Department—when Instrumentation was considered a necessary nuisance. At that time each man was a specialist on some particular type of equipment. As time went on, and more and more instruments and controllers were installed, it began to be apparent that specialization was not going to be the best answer. About that time Harry Moore (now Delegate, New Jersey Section) appeared on the scene and reorganized the department: from then on there were no specialists—anybody went to work on any type of equipment and some expert instrumentations were developed.

Now, however, according to Paul, many new types of instruments are being developed and installed, and it looks as though we will again need specialists. He said he felt that there will eventually be Instrument Engineering in the theoretical field and Instrumentation in the craft field and each will have its sub-branches, Electrical and Mechanical. The field is getting so large and so complex that no one man could be expected to know all about all types of equipment. Therefore, as his final

statement, Paul said that *Instrumentation is Headed Towards Specialization* again.

When Paul had finished his very interesting talk, the ensuing discussion made the Clubhouse sound like the floor of Congress during the introduction of a particularly hot bill. The discussion even carried over into the refreshment period provided by the Social and Recreation Committee, and the meeting did not break up until around 10 p.m.

At our next meeting on July 1, Mr. C. J. Griffin, Assistant Division Superintendent in charge of the Catalytic Department of the Aruba Refinery, will discuss "What is Expected of Instrumentation" from the viewpoint of the operator or customer.

—J. L. LOPEZ, *Sec'y.*

BALTIMORE

At the recent meeting of the Board of Governors of the Baltimore Section the following members were elected to govern the activities of the Section for the coming 1947-48 season, beginning in September:

President—Howard Halstead, Bethlehem Steel Co., Sparrows Point.
Vice-President — Edward P. Dempsey, Davison Chemical Co., Curtis Bay.
Sec'y-Treas.—Felix Cox, Bethlehem Steel Co., Sparrows Point.
Sergeant-at-Arms — Frank Gregloit, Crown Cork & Seal Co.
Governors: J. F. Malenshein, Brown Instrument Co., (Past President)
R. D. Mariner, Manning, Maxwell & Moore.
K. Miller, Davison Chemical Co., Curtis Bay.
Thomas Coyle, Maryland Glass Co.
Henry Wolbert, Standard Oil Co. of New Jersey.
R. Gilbert, E. I. du Pont de Nemours & Co., Curtis Bay.
Paul Donahue, Maryland Glass Co.

—KENNETH R. MILLER, *Corr.*

CHICAGO

Officers and Committee Chairman for 1947-48 Season:
President—Stanley A. Gray, Minneapolis-Honeywell Regulator Co.
Vice-President—Ralph R. Siechen, Universal Oil Products Co.
Treasurer—J. H. Cuthbert, Carnegie-Illinois Steel Corp.
Secretary—F. E. Ertsman, 3538 South Wabash Ave., Chicago (Section address).
Delegate—Earl C. Rieger, International Harvester Co.
Executive Committee:
R. R. Proctor (Past President) — The Pure Oil Co.
C. C. Hurst—Garden City Engineering Specialty Co.
J. J. Burnett—The Foxboro Co.
J. B. McMahon—Republic Flow Meters Co.
D. S. Dickey—Murphy and Dickey.
P. E. Cary—International Harvester Co.
Committee Chairmen:
Program—W. R. Dressler, Carnegie-Illinois Steel Corp.
Membership—J. H. Havens, The J. E. Lonergan Co.
Employment—C. E. Brackenridge, Sarco Co., Inc.
Technical Problems—A. M. Smeaton, Sanitary District of Chicago.
Housing and Reception—W. A. Wilkening, Corn Products Refining Co.
"Events"—J. C. Hayes, Garden City Engineering Specialty Co.
News Editor—R. R. Proctor, The Pure Oil Co.
Advertising Manager—O. J. Lessa, Ring Balance Div. The Hagan Corp.
Nominating—L. C. Laird, Corn Products Refining Co.
1947 Conference Committee—H. E. Ferguson, Peoples Gas Light & Coke Co.
JOURNAL Correspondent — Miss Sylva Mae Dushkes, Askania Regulator Co.

—S. A. GRAY, *Pres.*

CLEVELAND

The May meeting of the Cleveland Section, held at the Cleveland Engineering Society on May 28th, was a memorable one because of the large attendance at the dinner at 6:30 as well as at the meeting which followed at 8 o'clock, and the excellence of the talk by Mr. V. L. Parsegian of the C. J. Tagliabue Division of Portable Products Company on the subject of Thermocouple Methods of Temperature Measurement."

Before the general meeting there was a showing of a very interesting sound film, furnished by the Crane Company, showing the story of the pipe, valve and fitting business from the raw material stage to the finished product, emphasizing the care necessary in design, manufacture, testing and research in order to produce a finished article of high excellence.

President Sam Bousky opened the general meeting by giving a brief outline of the progress of the Section over the past year, during which time it became a charter member of the Instrument Society of America. Reports were heard from the outgoing officers and committee chairmen, and it was pointed out that the 1946 season started with a membership of only 54, which has now grown to a total of 128, a record of which we are justly proud.

The new officers, elected at the March meeting, were introduced, and committee chairmen for the 1947-48 season were announced and introduced. They are as follows:

President—Samuel Bousky
Vice-President—A. A. Hejduk
Secretary—Clark Joy
Treasurer—J. Prada
Committee Chairmen:
Program — Marvin Cleaton and G. Carnegie
Membership—A. J. McCullough
Publicity—L. H. Waldrip
Printing—Prof. Lawrence Siegel
Employment—Mandel Estrin
National Delegate—Harvey Lee

Reports were heard on the Spring Meeting in Cleveland, and announcements made regarding the 1947 Instrument Conference and Exhibit to be held in Chicago in September.

Mr. Parsegian's talk, which was illustrated by slides, was a gold mine of information on the theory and practice of temperature measurement by the thermocouple method, stressing the importance of careful selection of couple materials and their proper installation and calibration where high accuracy is desired. The paper and the lively discussion which followed were filled with many of the "do's and don'ts" which, when known and observed, make precision temperature measurements possible.

This meeting closes the activities of the Cleveland Section until the first fall meeting scheduled for September 24th, the details of which will be announced later.

—L. H. WALDRIP, *Corr.*

CUMBERLAND

The Cumberland Section held its last dinner-technical meeting of the spring season on Tuesday, May 27th, at the Queen City Hotel.

The speaker for the evening was Mr. W. W. Winters, Manager of Sales and Advertising for Automatic Temperature Control Company, Inc. His subject was "Time Controls in Industry," which proved very interesting and instructive to the 24 members and guests present at the meting.

The next meeting will be held June 5th, at which time the newly elected officers will be installed, followed by a social evening.—C. BABST, *Sec'y.*

DETROIT

Dr. M. H. Nichols of the University of Michigan's Research Center spoke on "Telemetering Problems in Modern Flight Research" at the May meeting of the Detroit Section. He was introduced by Mr. Thomas Kelly of the American Institute of Aeronautical Sciences, technical chairman of the evening.

The speaker gave a vivid description of the radio telemetering systems used in flight studies of piloted, remotely controlled and self-controlled aircraft and rockets, the latter ranging in size from 5 inches to 50 feet.

The systems described by Dr. Nichols transmit—on a single radio beam—as many as 24 channels of accurate information covering such variables as pressure, temperature, strain, force and acceleration. The talk was particularly interesting because it offered unusual bits of first-hand information dealing with the background of the guided planes and rockets tested, and left the audience with a better understanding of some of the difficulties and problems encountered in this field of research.

The exhibit of the H. H. Barnum Company was a working demonstration of the new Taco-West Veritron pyrometer controller which had been described by its designer, Mr. T. A. Cohen, at our January meeting.

At the business session preceding the meeting, chairman Gillig of the Nominating Committee reported on the election of officers for the 1947-48 season. Since the vote for president resulted in a tie, a run-off election was held. Officers for the coming season are:

President—Victor G. Raviolo, Ford Motor Company
Vice-President—Clarence Kushler, Champion Spark Plug Company
Secretary—Robert W. Gardner, Ford Motor Company
Treasurer—Siegmund Kulka, Vickers Inc.
National Delegate — Jack Richards, Brown Instrument Company.

The last meeting of the season, scheduled for Monday, June 23, will be a symposium on "Pneumatic Brains—Key to Low Cost High Quality Production" with a panel of speakers representing Micromatic Hone Co., Monarch Machine Tool Co. and Moore Products Co. This is to be a joint meeting with the Detroit chapter of the American Society of Tool Engineers. The discussion will be directed by Mr. L. B. Bellamy, chairman of the Detroit chapter, A.S.T.E., who will act as technical chairman of the evening. The June demonstration will feature Pneumatic Comparator Gages by Moore Products Company of Philadelphia, with Messrs. J. E. Gambrill and F. W. Blanchette in charge.

Plans are now being made for a joint picnic with the Wayne County Section to be held soon.—SIEGMUND KULKA, *Corr.*

NEW JERSEY

The final regular meeting of the New Jersey section was held as scheduled on June 3.

The meeting consisted of an inspection trip to the Bound Brook, New Jersey plant of the Calco Chemical Division of the American Cyanamid Company. Mr. John Kelly, their instrument maintenance supervisor and a member of the New Jersey Section of ISA, did an excellent job in organizing the inspection trip. The inspection trip was preceded by dinner in the Calco restaurant at which time the guests were introduced to the Production and Instrument Supervisors who had elected to act as guides on the trip through the plant. After dinner the visitors, numbering better than one hundred and twenty, were divided into four groups and conducted through the Power, Contact Sulphuric Acid, Nitric Acid and Pharmaceutical plants where everyone was able to observe the plant operations and Instrumentation.

Upon completion of the inspection trip the visitors gathered in the company auditorium for a question and answer period to discuss what had been observed.

All in all the evening was a complete success both from the standpoint of technical knowledge gained and the excellent organization work performed by the Calco personnel who are to be commended for the efficient manner in which they handled the large group which attended.

As previously reported, this meeting was a final one until October when we hope to be able to present for our membership series of interesting speakers. If our present plans materialize we hope to include our Fall and Winter meetings a series small exhibits from various instrument manufacturers. These exhibits will provide members and guests the opportunity to first hand knowledge of the manufacturers' more recent developments in the of instrumentation—H. M. McCARTHY, Sec'y.

NEW YORK

The 50th meeting of the New York Section was held at the Men's Faculty Club Columbia University on Monday, May A very interesting talk on "Relays and Circuits" was presented by Mr. C. J. Engineer, C. P. Clare & Co. A brief history of relay development preceded an explanation of simple applications of relays. This was followed by more complex circuits, particularly counter chains and intricate sequence circuitings, such as in telephone work. An explanation was given of problems and designs of relays to give certain desired results in order to permit this involved circuiting.

The blackboard was used freely by the speaker to illustrate various circuits, and a demonstration was given of counter chain applications. The question period which followed was confined mainly to relay operation problems and possible solutions.—CHARLES D. COREY, *Sec'y.*

OAK RIDGE

The regular June 3 meeting of the Oak Ridge Section featured Mr. Vernon D. Hauck, Chief Engineer of the Freiz Instrument Division, Bendix Aviation Corporation, Baltimore, Md., as guest speaker. The dinner portion of the meeting started at 7:00 p.m. followed by the business and technical meeting. Following the reading of the minutes of the last meeting and the report of the Program Committee, it was announced that the two forum sessions held last month would be conducted again this month at the request of the persons attending. These supplementary meetings on specialized subjects are apparently worthwhile since much interest has been shown, as evidenced by the attendance and the discussion at each of the preceding ones.

Mr. Hauck's subject was "Radiosondes." This very excellent talk, illustrated with slides and samples of radiosonde equipment, opened with a discussion of why it was necessary to gather upper air data. The 400 mc and 72 mc radiosondes were described, with particular emphasis on the temperature sensitive resistor elements and the humidity sensing elements. Mr. Hauck also described the ground station receiver with its recorders and indicators, as well as the engineering and construction details of instruments sent up in the V-2 rockets for gathering weather and flight data.

Mr. Ralph E. Sturm of the Research Department of the Bendix Aviation Corporation was a guest at the meeting, and assisted in the demonstration and discussion of several pieces of equipment which were available for inspection.

The Program Committee announced that the July meeting would be a forum session with local members as speakers. P. S. Buckley of Monsanto Chemical Company will speak on "Gimmicks"; D. M. Boyd of Monsanto Chemical Company will speak on the "Foxboro D. C. Dynalog"; and G. R. Jamieson of Carbide and Carbon Chemicals Corporation will speak on "The Uses of Capillaries for Measuring Small Flows."

The August meeting will feature a talk on "Induction and Dielectric Heating" by a representative of the Westinghouse Electric Corporation.—C. W. COVEY, *Corr.*

PITTSBURGH

The April meeting of the Pittsburgh Section was held on Monday, April 28, in the lecture hall of the Carnegie Library. After the regular dinner in the cafeteria, the members enjoyed a short motion picture entitled "Electronics at Work," produced by the Westinghouse Corporation. A brief business meeting was held during which Secretary Susany read the minutes of the previous meeting. Clark Fry gave a report on the state of the treasury, and Al Shafer, National Delegate, made a report on the Spring Meeting of the Board of Directors in Cleveland.

The subject "Automatic Proportioning of Gases and Liquids" was originally scheduled to be presented by Mr. B. J. Velten of Askania Regulator Company. However, Mr. Velten was unable to attend and his place was taken by Mr. W. R. Fray of the same company.

The last meeting of the Pittsburgh Section for the current season was held Monday, May 26, at the Carnegie Library lecture hall. At the business meeting following dinner, Paul Exline, chairman of the Program Committee, suggested that the September meeting consist of brief reports of the more important papers given at the Annual Instrument Conference in Chicago. For the October meeting it was suggested that a symposium be held on different phases of one of the following subjects: laboratory instrument problems, pressure measurements, temperature measurement, problems of calibration, steel mill instrumentation. It was requested that the members suggest the names of competent speakers to the Program Committee.

Al Shafer gave a report on the progress of the Chicago show and said that the final program would be published soon.

Due to an error in printing, the annual ballots could not be sent out to the members in time; consequently the present officers will maintain their positions until the end of next month. Corrected ballots will be mailed to the membership in the near future.

At the suggestion of President Sam Prince, the membership moved to reserve a room at the Stevens Hotel in the name of the Pittsburgh Section for the duration of the Chicago Conference as a meeting place and for the convenience of the Pittsburgh members.

The subject for discussion for the evening, "Time Controls in Industry," was very ably presented by Mr. W. W. Winter of the Automatic Temperature Control Company of Philadelphia. After a brief question period the meeting was adjourned.—A. G. YOUNG, *Corr.*

SOUTHERN MICHIGAN

The Southern Michigan Section held its May 21st meeting at Chicken Charlie's in Kalamazoo. Fifty members and their guests attended.

President Wade Allen called a short business meeting after the dinner at which details of the Section's election of officers were announced. Devere Curran of the Nominating Committee presented a proposed slate of officers for the coming year, which slate will be mailed to all Section members before the June meeting, at which time the election will be held.

Herb Barnum, I.S.A. Vice-President, was a guest at the meeting.

The subject "Electronic Mechanics of Pyrometry" was very ably discussed by Mr. Theodore A. Cohen, president of the Taco-West Corporation of Chicago. Mr. Cohen explained, with blackboard sketches, the uses of the vacuum tube as a rectifier, an amplifier, and as a relay to control large voltages and currents. The various ways of changing the minute d.c. voltages from a thermocouple to a.c. so they can be amplified were discussed in detail. Included were synchronous motor-driven rotary contacts, vibrators, synchronous vibrators, rotar condensers, saturable core reactors, meter relays, and electronic oscillators. The advantages and disadvantages of each were discussed, and the speaker concluded with a description of the new Taco-West Veritron pyrometer controller, of which he is the designer.

The talk was followed by a lively question and answer period.—KEN MEAD, *Corr.*

SOUTH TEXAS

The South Texas Section presented Mr. F. C. Brandt of the Minneapolis-Honeywell Regulator Company as guest speaker at the June 2nd meeting. Mr. Brandt proved interesting and informative, presenting a talk on "Air Conditioning" and giving a practical demonstration of some of the control units used in this field.

On June 26 the Section will present Mr. Lyle Eige of the Fisher Governor Company, Marshalltown, Iowa. This meeting will be held in conjunction with the South Texas Engineering Society, as his lecture on "Characteristics of Regulators" will be of interest to both societies. Refreshments will be in order at the close of the meeting.

Much credit for the series of interesting meetings we have had must go to Mr. J. G. Pratt, our Program Committee Chairman. For our next meeting, scheduled for early in July, tentative plans have been made for a barbecue, to be held at the La Gloria Corporation in Falfurrias, Texas.—BEULAH M. SMITH, *Corr.*

TENNESSEE

The Tennessee Section held its annual business meeting on May 14 at the Kingsport Inn. A dinner at 7 p.m. was attended by a majority of members, with the business meeting following.

Retiring President J. T. Elder called the meeting to order, and the activities of the past year were covered in a report by retiring Secretary F. H. Thiele, Jr. Mr. A. W Bright gave the treasurer's report, and to the members' surprise the Section is completely solvent.

The following officers were elected for the coming year:

President—F. H. Thiele, Jr., Tennessee Eastman Corp.

1st Vice-President—J. H. Rion, Tennessee Eastman Corp.

2nd Vice-President—Robert Paris, American Bemberg Corp.

Secretary — L. W. Thayer, Tennessee Eastman Corp.

Treasurer — A. W. Bright, Tennessee Eastman Corp.

JOURNAL Correspondent—J. D. Barnes, Tennessee Eastman Corp.

A committee was appointed to draft a letter to the National Office in an attempt to clear up the question of membership in the Section. All members took an active part in the discussion of several questions, and it was agreed that the June meeting would be held as an annual outing at the Tennessee Eastman Cabin Grounds. This is to be the last meeting until fall.—L. W. THAYER, *Sec'y.*

WASHINGTON

The May meeting of the Washington Section was held Monday, May 19, at 8:00 P.M. in the Pepco Auditorium.

Because of the efforts of our publicity chairman and the general interest in our topic, "Railroadin' ", we are pleased to announce that we surpassed all previous records with 173 in attendance.

The saga of railroading portrayed in a 30 minute technicolor movie was shown first so that those interested only in the movie could leave early. To our surprise most of the people stayed for the main feature of the evening, a talk on railroading entitled "Instrument Applications in Railroad Signaling," given by Mr. George W. Baughman, Chief Engineer, Union Switch and Signal Construction Company.

Mr. Baughman's talk, illustrated with slides, covered railroad signaling devices from their infancy to the present day.

The talk which brought to light many factors of railroad signaling not commonly known aroused much interest in the mixed group as evidenced by their attention to the talk and their many questions.—G. M. ROLLS, *Corr.*

WAYNE COUNTY

The Wayne County Section met on Monday, June 16. The program for the evening was an inspection trip through the Blast Furnace Division of the Great Lake Steel Corporation.

Approximately 35 members and guests enjoyed a very interesting trip seeing the many items of interest including the blast furnaces, coke ovens, instruments and controls. Our thanks go to the management of the Blast Furnace Division and to W. R. Tate and his associates for the effort spent in making this trip a success.—W. G. BAKER, *Corr.*

Who's Who in the I. S. A.

ALBERT F. SPERRY

(Past-President, Member of Executive Committee, Chairman of National Meetings Committee)

The first president of the Instrument Society of America, "Al" Sperry proved to be a natural organizer and was instrumental in ironing out a great many of the organizational difficulties during his term of office ending last September (1946). As chairman of the National Meetings Committee, he is responsible for the sub-committees and many of the details of the 1947 Conference and Exhibit to be held in Chicago this coming September 8-12.

Al was graduated from Rensselaer Polytechnic Institute in 1923 with a degree in Electrical Engineering. Being the son of Jacob M. Spitzglass, inventor of the first electric flow meter, Al was very much interested in flow control, and he eventually found himself working for Republic Flow Meters Company in Chicago. Sometime during the 1930's he was made Vice- President in charge of Engineering for Republic, and had begun to make a name for himself as an inventor in the automatic control field. (He has approximately 50 patents in this field at present.

In 1917 Al branched out on his own as a Consulting Engineer. He was a General Consultant, specializing to some extent in Power Plants till 1940. At that time he narrowed down the field considerably, specializing in instrumentation and control problems, and serving as engineering expert in connection with patent litigation on control apparatus. While he is still engaged in some consulting work, he recently became President of Pannellit, Inc., manufacturers of Central Control Units for the chemical industries.

Besides being a member of the Chicago Section of the I.S.A. and Past-President of the National Society, Al is a member of the American Institute of Electrical Engineers and of the American Society of Mechanical Engineers. In the latter he is chairman of the Committee on Theory of the Industrial Instruments and Regulators Division, and Secretary of the Committee on Automatic Regulation Theory, Special Research Committee. In addition, he is a Registered Professional Engineer in the States of Iowa, Michigan and Illinois.

Al is married and has two daughters, both now enrolled at the University of Chicago. His hobbies include piano playing (and he's very good at it, too) and, of all things, Automatic Control Theory. He is the author of numerous publications in this field, some of them under the name of Spitzglass, and all of them authoritative.

Because of his many contacts and his organizing ability, Al was able to steer the I.S.A. through its first year with flying colors, and turn over a going concern to his successor, C. O. Fairchild. For this, the Society owes a vote of thanks and appreciation to Al Sperry for a tough job well done.

RICHARD RIMBACH

(Executive Secretary)

Richard "Dick" Rimbach is probably as well known in the instrument industry as any other one man in the I.S.A. His activities in this field, as well as in others, are many and varied. As organizer and publisher of INSTRUMENTS magazine and THE INSTRUMENT MAKER, Dick was active in the organization of many local Instrument Societies, and was a member of most of these groups before the Instrument Society of America as organized. He also organized the first Gibson Island AAAS Instrument Conference, and was a member of the committee under the chairmanship of Al Shafer (appointed by R. J. S. Pigott) to invite the local Instrument Societies to a meeting to discuss the organization or a national instrument society.

Dick was born in New York City on December 24, 1895. His education includes B. S. degrees from both M.I.T. and Harvard, and his listings in "Who's Who in Engineering 1947" and "American Men of Science 1944" reveal the following highlights of his career:

Metallurgist, Illinois Steel Co., 1916 Director of Research Standard Steel Car Co., 1920-22; Foreman, Jones & Laughlin Steel Corp., 1923; Research Engineer, Union Switch & Signal Co., 1924-25; Consulting Engineer, Bacharach Industrial Instrument Co., 1926-27; Managing Editor INSTRUMENTS Magazine, 1928 to date; Consulting Editor of METALS & ALLOYS, 1929-36, and CORROSION & MATERIAL PROTECTION, 1944; Licensed Professional Engineer, Pennsylvania. During the late war Dick was in charge of the Research Information Section, War Metallurgy Committee, and Advisor to both the U. S. Army Engineer Board and the Electrical Instrument Section of the War Production Board. In addition he was for a time Technical Advisor to the Standard Steel Spring Company, and an Instructor in Metallurgy (night school) at Carnegie Institute of Technology.

Some of Dick's other activities includes membership in the Instrument Industry Advisory Committee, Industrial College of the Armed Forces, I.S.A., A.S.M.E., A.C.S., A.S.T.M., A.S.M., Electrochemical Society, American Electroplaters Society, National Association of Corrosion Engineers, Corrosion Forum and Material Handling Society. He is the author of "How to Find Metallurgical Information" and the translator of a number of German technical books.

In addition to being Executive Secretary of the I.S.A., Dick is active in other phases of the organization, being manager of the Instrument Exhibit, chairman of the Membership Committee, secretary of the Public Relations Committee, and a member of the Executive Committee, the Finance Committee, the Meetings Committee and the Publications Committee.

Despite the tremendous amount of time demanded by his many activities, Dick finds time to enjoy his family and home in Perrysville, just outside of Pittsburgh. Here he "relaxes" occasionally with his wife, Martha, and their three children, Richard Jr., Martha and Gretchen.

LAWRENCE F. PARACHINI

(Chairman, Sub-Committee (of Education Committee) on Electrical Instruments

Many of the readers of this column will learn a lot more about "Larry" Parachini at the 1947 Conference and Exhibit in Chicago September 8-12. As Manager of Educational and Public Utility Sales for Weston Electrical Instrument Corporation, Newark, New Jersey, Larry was the logical choice as chairman of the Electrical Instruments Sub-committee of the I.S.A. Educational Committee, and as such, will be an active participant in the short courses to be offered at the Conference this year.

Larry was graduated from the Newark College of Engineering in 1932 with a B.S. degree in Electrical Engineering, and has been associated with Weston almost continuously since that time. He is a member of the New Jersey Section of the I.S.A., the American Institute of Electrical Engineers, Newark Technical School Fraternity, Newark Athletic Club, and Tau Beta Pi. He is well known as a speaker, having appeared before many Sections of the I.S.A. during the past two or three years, the Instrumentation Conference at Carnegie Tech in 1946 and in the short courses on electrical instruments at the 1946 Instrumentation Tomorrow Conference in Pittsburgh in September.

Larry is married and has two children, Lawrence F., Jr., (10) and Patricia (6). His hobbies include photography, radio and sports. The Parachini residence is at 1 Chestnut Street, Nutley, N. J.

Look for Larry at the Chicago Conference where he will be in charge of the Electrical Instruments School Sessions at the Stevens Hotel at 9 a.m. and 2 p.m. Tuesday and Wednesday, Sept. 9 and 10.

DR. TEARE RECEIVES WESTINGHOUSE PRIZE

The George Westinghouse Award for distinguished contributions to engineering education has been bestowed upon Dr. B. Teare by the American Society for Engineering Education.

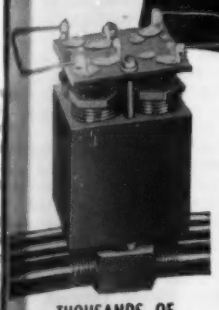
Teare is known to all ISA members as chairman of the Society's Education Committee. He is head of the Department of Electrical Engineering and Buhl Professor at the Carnegie Institute of Technology.

Plan Now To Attend • **1947 I. S. A. CONFERENCE AND EXHIBIT**
September 8-12, 1947 **Stevens Hotel, Chicago**

Low cost gas analysis!

ACCURATE...
SENSITIVE...
COMPACT...
RUGGED...

with GOW-MAC EVER-TITE THERMAL CONDUCTIVITY UNITS



THOUSANDS OF GOW-MAC UNITS are performing various gas analysis functions in laboratories, petroleum refineries, aircraft carriers, chemical plants and process industries. Write for bulletin, E-47

GOW-MAC units provide a rapid, accurate and very inexpensive means of observing gases by the well-known thermal conductivity method. They require no special instruments, only standard accessories found in any laboratory or instrument department.

Typical applications include special atmospheres, gas synthesis, inert gas generation and distribution, efficiency of internal combustion engines and furnaces and wherever hydrogen and CO_2 are found. Units may be used with indicating, recording and controlling instruments. Extremely adaptable to gas flow needs.

Special features of construction result in high sensitivity, excellent stability and long life relatively unaffected by vibration or ambient change. All cells are tested at 10 psi before shipment. Parts are precision machined and assembled without the use of glass or cement.

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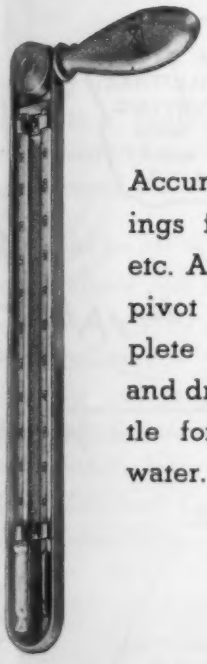
H-B Sling Psychrometers



★

Accurate humidity readings for air conditioning, etc. Aluminum frame with pivot handle. Comes complete with extra wicking and dropper-equipped bottle for applying distilled water.

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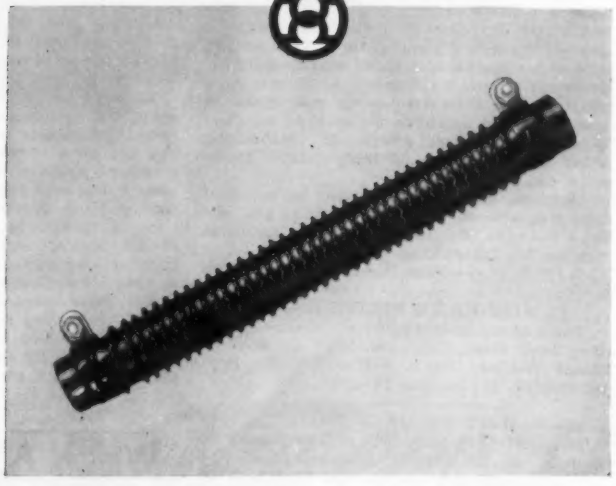
H-B INSTRUMENT CO.
2518 NORTH BROAD STREET, PHILA. 32, PA.

HARDWICK, HINDLE
Crinkle Wound
Resistor



OUR CRINKLE WOUND resistors are designed especially for relatively low value of resistance with a high current carrying capacity.

They fall within the classification of bare resistors by NEMA and Underwriters' regulations, permitting operations at a temperature rise of 350 degrees C.

The ribbon of resistance alloy is wound on edge upon the refractory tube—the ends braised to heavy copper terminals. A vitreous enamel covering anchors the turns securely and prevents movement. *The result is an unusually large area for heat dissipation.*

Units with intermediate taps are available. There are 5 sizes: 155 to 420 watts, from .125 to 20.0 ohms

Hardwick, Hindle resistors and rheostats offer many exclusive advantages. We ask you to give our engineers an opportunity to discuss your specific requirements.

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NEWARK 5, N. J. Established 1886 U. S. A.

Technical Society News

AKRON INSTRUMENT SOCIETY

The last regular meeting of the 1946-47 season was held at Spindler's Inn, Cuhahoga Falls, O., on Tuesday, May 27th. President Stanley T. Wepsic opened the brief business session after some 50 members and guests had disposed of considerable quantities of chicken, etc.

Past President C. B. Luther introduced V. J. Parsegian, who spoke on "Pyrometry —Electrical Methods in Temperature Measurements." High accuracy may be coupled with high response speed if the extra expense is justified, he explained, then discussed the world-wide primary and secondary standards of temperature. The subject of thermocouples and their manufacture interested Society members so much that most of the time remaining was spent in questions and answers on making up couples, testing wire, effects of introducing other metals, effect of temperature gradients, etc.

Members and friends present agreed that this was one of the best meetings yet. We hope to have Mr. Parsegian back again to resume his interesting discussion.

—FRED APPEL, JR., *Secretary*

AISS PICKS PITTSBURGH

The annual meeting of the Association of Iron and Steel Engineers will be held at Hotel William Penn, Pittsburgh, on September 22, 23, 24 and 25, 1947.

E. G. BAILEY TO HEAD ASME IN 1948

The 1947-1948 president of The American Society of Mechanical Engineers will be E. G. Bailey, New York, vice president of The Babcock and Wilcox Co., founder in 1916 of the Bailey Meter Co. and its president until 1944 when he became chairman of its board. "E. G." was the only nominee for the presidency at the Semi-annual Meeting, Chicago, June 15-19.

Among his inventions are fluid meters, boiler meters, automatic combustion controllers, as well as boilers and furnaces. He is the author of many technical papers.

MAINTENANCE OF TEMPERATURE INSTRUMENTS

Instrumentation in steel industrial units has made rapid advances during the past decade. Today the Instrument Department finds its facilities projected into every phase of the production picture. So stated H. C. Morrow, Test and Meter Repairs, Power and Fuel Div. of Carnegie-Illinois' Gary Sheet and Tin Mill, before the Association of Iron and Steel Engineers in Chicago.

In the Department's works at the Gary Sheet and Tin Mill, we constantly find new highly-practical applications for instrumentation and, in many instances, the use of a given type of equipment for one purpose in turn gives rise to several other types of equipment in the solution of a single problem—or results in the application of such a development to other manufacturing conditions.

Numerous quality, yield and production rate problems, long known to both supervision and employee personnel, have been solved through instrumentation. The chief factor in this is the ability of the instrument to point out the precise location of difficulties which often are hidden in the equipment or process under study. It follows that the instrument utilized in detecting the difficulty may not be identical with that adopted for final correction.

In operation, the servicing and maintenance of all instruments is predicated upon the availability of precision checking equipment; therefore, in the shop a Type K precision potentiometer with a Bureau of Standards certified standard cell and standard thermocouples are maintained as the plant standard for all measurements and calibrations. As auxiliaries, for both shop and field work, a battery of eleven portable potentiometers of various ranges and thermocouple types are maintained, in addition to Wheatstone bridges, circuit analyzers, tube testers, voltmeters, ammeters, etc.

Major shop activities consist of the rebuilding, repair and servicing of relays, motors, meters, and such instrument units as may require recalibrating, range changing, etc., not feasible in the field.

Each shipment of thermocouple wire received at Gary Sheet and Tin Mill, irrespective of its intended application, is routed directly to the shop for standard accuracy analysis. The importance of this precaution may be realized when it is considered that more than 1000 thermocouples, varying from 15″ to 28 feet in length, are fabricated, tested and installed in production use monthly in our plant.

As another major responsibility of this shop, the maintenance and calibrating of optical pyrometer units is accomplished with the aid of a check set embodying a 0.001 standard shunt and flat filament lamp, furnished and recalibrated at regular intervals by the U. S. Steel Corp. Research Laboratory. A system of stated interval checking of all optical units is in operation. Calibration and adjustment of radiation tubes is also accomplished at regular intervals.

For instrumentation service, the operating divisions are grouped into five sections, with one or two service men in each, depending upon its size, amount of equipment, etc. Daily, the service man first makes a complete inspection of all equipment in his supervision, replaces charts, inks, pens, standardizes instruments, etc. He also reports items requiring further attention and returns to them upon completion of the inspection, or notifies the instrument foreman who, in turn, assigns the work to the proper men. These men determine whether or not the equipment can be serviced in the field or must be returned to the shop. If the latter is decided upon, they must set up temporary controls in order that the process work will not be interrupted. The service man is responsible for the entire control installation, from primary element to the final control valve. Twenty-four-hour instrument service, seven days a week, is available to any division.

Certain fundamentals must be recognized for effective temperature indicating and control instrumentation. These include: (1) high-precision equipment in any control application; (2) "engineering" any measurement or control installation to the specific conditions of the job; (3) absolute adherence to a proved plan for installation and operation; (4) close liaison between Operating Department personnel and the Instrument Department to develop better understanding of instruments, their importance and benefits; (5) willingness of instrument manufacturers to coöperate in all phases to established requirements and the development of specific applications.

WHEN A FELLER NEEDS CONTROL BY Putt
HEAT TREAT DEPT.
DROP HAMMER DEPT.
BUT-YOU CAN'T EXPECT THEM TO BE ACCURATE WITHOUT SHOCK MOU-
WHADYAMEAN SHOCK MOUNTING!! ALL THEY NEED IS ADJUSTING BY SOMEONE WHO KNOWS WHAT HE'S DOING!
WHAM
CAREFUL — HOT STUFF
INSTRUMENT MAINTENANCE
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Instruments pays $5.00 for each idea used. Sender's name and company affiliation will be acknowledged in the cartoon unless we are specifically requested not to do so.
Address Cartoon Dep't, *Instruments*, 1125 Wolfendale St., Pittsburgh 12, Pa.

Easy on the eyes!

U. S. Radium Luminescent Dials enable pilots to see better

Pilots of the new super-airliners have plenty of instruments to read! To make the dials as legible as possible . . . and especially to eliminate glare at night . . . commercial airlines specify that all letters, numerals, and graduations on scales must be self-luminous.

To meet this specification with assurance of full satisfaction, leading aircraft-instrument manufacturers use U. S. Radium dials and pointers. The bright self-luminous markings — precisely applied — are easy to read in daylight, artificial light, or darkness.

Leading aircraft-instrument makers choose U. S. Radium dials because of their bright, long-lived luminescence and accurate markings

Above you see one of four types of indicators, equipped with U. S. Radium dials, which are supplied with the Simmonds Pacitor Gauge — a highly reliable, electronic fuel gauge manufactured by Simmonds Aerocessories Inc., New York, and currently being installed in Douglas DC-6, Lockheed Constellation, Consolidated Vultee 240, and other aircraft.

LUMINESCENT DIALS FOR OTHER INSTRUMENTS

U. S. Radium is producing dials for a wide variety of instruments and timepieces — using long-lived luminescent materials in a range of brilliant, standardized colors.

The services which U. S. Radium offers you include (1) designing dials for luminescence; (2) start-to-finish production of luminescent dials, pointers, or other components; (3) application of self-luminous, fluorescent, or phosphorescent materials to existing dials; (4) production of highly precise nonluminescent dials. To find out how any of these services may increase the utility, accuracy, or saleability of *your* instruments, write to *Dept. 13, U. S. Radium Corp., 535 Pearl St., New York 7, N. Y.*

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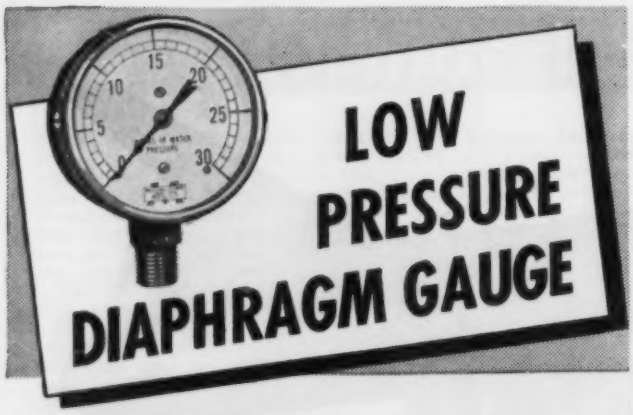
Luminescent Dials



MARSHALLTOWN Figure 83 is a very sensitive instrument utilizing a diaphragm for pressure communication, and is recommended for extremely low pressure service.

The following standard dials reading in inches of water are available—0-15", 0-30", 0-60", 0-100", 0-150".

Ounce graduated dials can also be supplied in a range from 16 ounces to five pounds.

It is available in the 2½", 3½", and 4½" dial sizes and mounted in a black enameled, deep steel case. Write for details and price.

MARSHALLTOWN manufactures one of the most complete lines of indicating pressure gauges—there is a Marshalltown gauge for every purpose and pressure.

Marshalltown Mfg. Co., Marshalltown, Iowa

No. 17 ROCH VERNIER CALIPER

Made by the world famous Swiss precision instrument maker P. Roch, this Etalon Caliper is made of the finest rustless hardened steel with extreme accuracy both in design, construction and markings. It is an all-purpose Caliper with precision locking device and a capacity of 7 inches. (Larger Models also available).

Extremely sharp knife edges increase accuracy in use, while careful inspection of every instrument before shipment eliminates any danger of error.

The Caliper is supplied with form-fitting leatherette plush lined case with cover.

SPECIAL FEATURES

1. Combination inside and outside measurement with knife edges. Convenient depth gauge included. All readings on same vernier.
2. Constructed entirely of stainless tempered steel.
3. Readings in 1/1000th inch. Instruments supplied with metric and English reading or English only.
4. Quick acting precision lock by simple thumb screw.
5. Swiss craftsmanship gives instrument the precision and accuracy of a fine watch.

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Manufacturers' New Literature

In this department we report new literature pertaining to Instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on page 657.

O-329 **Speed Indicators.** 4-page 8½" × 11" Bulletin pictures and describes maker's line of electric tachometers for engine and industrial applications. Westberg Mfg. Co., 6592 Onarga Ave., Chicago 31, Ill.

O-330 **Anti-capacitance Switches.** Single sheet 8½" × 11" pictures and describes maker's anti-capacitance switches in four types. Federal Anti-Capacity Switch Corp., 106 Kingsley St., Buffalo 8, N. Y.

O-331 **Automatic Inspection System.** 6-page 8½" × 11" Bulletin pictures and describes the "Limitron" automatic inspection system for inspecting small parts up to 7000 pieces per hour. Arma Corp., 254 36th St., Brooklyn 32, N. Y.

O-332 **Accessories for Wear-testing Machine.** 12-page 8½" × 11" Bulletin No. 4702 pictures and describes a line of accessories for use with the "Taber Abraser." Taber Instrument Corp., 111 Goundry St., North Tonawanda, N. Y.

O-333 **"Biddle Instrument News."** 4-page 8½" × 11" Vol. 3 No. 1 of this house organ contains several articles on the use of "Megger" instruments. James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa.

O-334 **D-c. Selsyn Application Data.** 20-page 8½" × 11" Bulletin GET-1304 pictures and describes maker's d-c. Selsyn position-indicating equipment originally designed for aircraft and suggests industrial applications. General Electric Co., Apparatus Dept., Schenectady, N. Y.

O-335 **Temperature-measuring Accessories.** 28-page 8½" × 11" catalog pictures and describes maker's thermocouples, protection tubes, lead wires, quick-coupling connectors, pyrometers, industrial furnaces, etc. Thermo Electric Co., Fair Lawn, N. J.

O-336 **"The Oscillographer."** 12-page 6" × 9" Vol. 8 No. 3 of this house organ is devoted to an article, "Uses of the Cathode-ray Oscillograph in Transmitter Adjustment and Control," by S. H. Coombs. Allen B. Du Mont Laboratories, Inc., 2 Main Ave., Passaic, N. J.

O-337 **Electronic Timer.** 4-page 3¼" × 6" Bulletin pictures and describes the "Lumidial" electronic timer with luminous dial for use in dark rooms. Assembly Products, Inc., Chagrin Falls, Ohio.

O-338 **Valve Position Indicators.** 8-page 8½" × 11" Catalog F pictures and describes maker's line of dial-indicating handwheels, valve position indicators and high-lift v-port hand regulating valves. Tejax Engineering Corp., 1 Allens Ave., Providence, R. I.

O-339 **Instruments for Testing Petroleum Products.** 40-page 8½" × 11" Catalog No. 699G pictures and describes maker's line of standardized instruments for testing petroleum products, including also laboratory thermometers and hydrometers. C. J. Tagliabue Div., Park and Nostrand Aves., Brooklyn 5, N. Y.

O-340 **Rotameters.** 24-page 8½" × 11" Catalog Section 25-E pictures and describes "Series 700 Flowrators" for measuring flow rates of liquids and gases. Fisher & Porter Co., Dept. 5C, Hatboro, Pa.

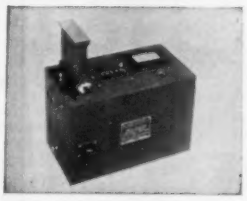
O-341 **Draft Gages.** 20-page 8½" × 11" Bulletin 46-667 pictures and describes maker's line of pointer-type draft gages for indicating and recording drafts, pressures, differentials and temperatures. The Hays Corp., Michigan City, Ind.

O-342 **"General Radio Experimenter."** 8-page 6" × 9" Vol. 21 No. 11 of this house organ is devoted to an article describing a wide-frequency-range capacitance bridge. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

O-343 **Engine-testing Dynamometers.** 4-page 8½" × 11" Bulletin MD-1 pictures and describes maker's universal-type engine testing dynamometers for motoring directly from an a-c. line. Dynamatic Corp., 3307 14th Ave., Kenosha, Wis.

O-344 **"The Ohmite News."** 2-page 8½" × 11" April 1947 issue of this house organ contains an article on the use of maker's rheostats for controls in the direct-reading transconductance tube

EASY
to Make Moisture Tests with a Steinlite



No technical education is needed to operate the electronic Steinlite. The main things to be done are (1) turn on a switch, (2) weigh a small sample, (3) pour sample into hopper, (4) read a dial, (5) get percentage of moisture by comparing dial reading with chart. These operations are done very quickly. Numerous users report making a test in one minute

Steinlite is accurate and reliable . . . calibrated against official over methods. Tests moisture content of dehydrated foods, cocoa, grains, feeds, nuts and a host of other products. Sold on free trial basis. Available for prompt shipment.

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Cyclohm | SYNCHRONOUS CAPACITOR TYPE MOTOR

This new Cyclohm 29 Size has no equal as a synchronous, capacitor type motor for recording, tape pulling, facsimile work and other jobs which require a *quiet, smooth, vibrationless* motor. Internal rotor slots permit a higher starting torque and a quieter performance. Substantial cap seats, turned in the frame and end caps, ensure perfect rigidity, accurate bearing alignment, uniform air gap, and a vibration-free motor. Supplied with either ball bearings or sleeve bearings — in ratings of 1/100, 1/75 and 1/50 horsepower, 1800 r.p.m., 115 volts, 60 cycles. Write for complete information.

CYCLOHM MOTOR CORP.
5-17 46th Road, Long Island City 1, N.Y.

tester. Ohmite Mfg. Co., 4835 Flournoy St., Chicago 44, Ill.

O-345 **"Electronic-Pneumatic-Mechanical Instrumentation."** 32-page 8½" × 11" Vol. 2 No. 5 of this house organ contains several articles including "Locke Insulator Makes Wide Use of Industrial Instruments" by C. W. Bowden, Jr., and "Progress in Oil Refinery Instrumentation Through Electronics" by J. A. Pelletere. Brown Instrument Co., Wayne and Roberts Aves., Philadelphia 44, Pa.

O-346 **Feed Regulator.** 4-page 8½" × 11" Technical Bulletin No. 7 pictures and describes maker's automatic feed regulator for mechanical and vibratory feeders on pulverizers and other processing equipment. Mosher Electronic Controls, 130 W. 42nd St., New York 18, N. Y.

O-347 **"The C-D Capacitor."** 16-page 8½" × 7½" Vol. 12 No. 3 of this house organ contains an article, "Audio Amplifier Equalization Methods." Cornell-Dubilier Electric Co., Hamilton Blvd., South Plainfield, N. J.

O-348 **Electrical Instrument Repair Tools.** 4-page 8½" × 11" bulletin pictures and describes maker's line of special tools for the repair and assembly of electrical instruments. Ideal Laboratory Tool and Supply Co., 3619 Evans Ave., Cheyenne, Wyo.

O-349 **Recording Instruments for Temperature and Pressure.** 24-page 8½" × 11" Catalog No. 1210A pictures and describes maker's line of recording instruments with 9", 10" and 12" charts. Temperature instruments cover mercury-actuated, vapor-tension and gas-filled. Range of pressure instruments covers less than 0 to 6" water vacuum or pressure to 4001 lbs. pressure and up. C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn 5, N. Y.

O-350 **Micro Match.** 8-page 6" × 9¼" bulletin pictures and describes the theory of operation of this instrument for measuring standing wave ratio and r-f. power. M. C. Jones Electronic Co., 98 N. Main St., Bristol, Conn.

O-351 **Instruments for Industrial Laboratories.** 2-page 9½" × 14" wall chart covers the characteristics of fifteen laboratory instruments. A diagram accompanies each to show the basic arrangement. North American Philips Co., 100 East 42nd St., New York 17, N. Y.

O-352 **"Tong Test" Ammeter.** 6-page 8½" × 11" bulletin pictures and describes instrument for reading current without breaking the circuit, scraping the insulation or touching the conductor. Columbia Electric Mfg. Co., 4519 Hamilton Ave., Cleveland 14, Ohio.

O-353 **Tube Checker.** 4-page 8½" × 11" bulletin pictures and describes new tube checker that meets AURMA Standards and tests the tubes for filament continuity, heater cathode leakage, open elements, shorted elements and quality of emission. General Electric Co., Electronic Dept., Syracuse, N. Y.

O-354 **Feed Water Regulator.** 8-page 8½" × 11" Bulletin No. 471 pictures, diagrams and describes "Copes Type T" regulator available as a single-element unit for simple level control or as a two-element "Flowmatic Control." Northern Equipment Co., Erie, Pa.

O-355 **Dehydrator.** 24-page 8½" × 11" booklet pictures, diagrams and describes the "Lectrodryer" for dehydrating air and other gases in many industries such as oil and gas, dry-ice manufacture, heat treating, chemical processes, etc. Pittsburgh Lectrodryer Corp., P. O. Box 1766, Pittsburgh, Pa.

O-356 **Decade Scaling Unit.** 4-page 8½" × 11" bulletin pictures and describes instrument for application in nuclear research, radioactivity, mass spectrography, timing, calculating machines and counting rapidly-recurring phenomena. General Electric Company, Electronic Dept., Syracuse, N. Y.

O-357 **"General Radio Experimenter."** 8-page 6" × 9" Vol. 21 No. 12 of this house organ is devoted to "Connection Errors in Capacitance Measurements" and two short articles on the Variac adjustable auto-transformer. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

O-358 **Thermostat.** 2-page 8½" × 11" folder pictures and describes the "Mighty Mite" thermostat, dimensions 1¼" × 3/16" × 5/16", pre-set to given specifications for application to heat control problems. Mechanical Industries Production Co., 217 Ash St., Akron 3, Ohio.

O-359 **Surface Comparator.** 4-page 8½" × 11" bulletin 32A presents a new instrument for rapidly comparing the surface finish of production parts. The Comtor Co., 87 Rumford Ave., Waltham 54, Mass.

O-360 **Hygrometer.** 8-page 8½" × 11" bulletin No. 201 pictures and describes an improved instrument for the accurate measurement of relative humidity. Serdex, Inc., 91 Cambridge St., Boston 14, Mass.

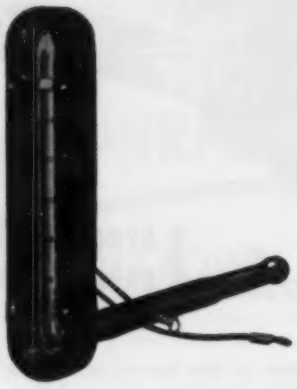
O-361 **Recorder Charts.** 36-page 8½" × 11" chart catalog No. 1230A pictures numerous 9, 10 and 12" charts for recording instruments for all ranges of temperature, vacuum and pressure. C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y.

O-362 **Inspection Lights With Mirrors.** 24-page 8½" × 11" booklet pictures and describes the "Vanco" line of inspection lights with mirrors for inspection and repair work of hidden parts. Van Wagner Co., 89-04 113th St., Richmond Hill 18, N. Y.

O-363 **"The Graphic."** 4-page 8½" × 11" No. 1246 issue of this house organ lists the bulletins issued by this com-

For Extremely Close Temperature Control

Visual-Stats



Extreme sensitivity is easily attainable. Mercury column visible at control point (where most important) because electrodes terminate at back of tube. No encircling metal bands. Available in angle form.

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The Philadelphia Thermometer Co.
Sixth & Cayuga Sts. -:- Philadelphia

Oldest Thermometer Manufacturer in Philadelphia

tures maker's line of test equipment with latest price list. Triplett Electrical Instrument Co., Bluffton, Ohio.

O-370 **Spectrophotometer.** 8-page 8½" × 11" Bulletin B-211 pictures and describes the "Coleman Junior Spectrophotometer" with new interchangeable scales for the analytical laboratory requiring a variety of different analyses from a single instrument. Boder Scientific Company, 719-721 Liberty Ave., Pittsburgh 22, Pa.

O-371 **Measurements of Radioactivity.** 6-page 8½" × 11" Data Sheet No. 3 pictures and describes maker's instruments for the detection of ionizing radiation. A page is devoted to the terminology commonly used in radioactivity measurements. Radiation Counter Laboratories, 1451 E. 57th St., Chicago 37, Ill.

O-372 **Automatic Controllers.** 4-page 8½" × 11" bulletin pictures and describes diaphragm control valves, direct-operated controllers, liquid-level controllers, self-contained pressure regulators, pilot-operated pressure regulators, pump governors and gas regulators. Fisher Governor Co., Marshalltown, Iowa.

O-373 **Lever Action Switches.** 4-page 8½" × 11" bulletin of engineering data pictures, diagrams and describes a line of switches particularly adapted to intercommunication, centralized radio, sound distribution and public address equipment. P. R. Mallory & Co., Indianapolis 6, Indiana.

O-374 **Megacycle Meter.** 4-page 8½" × 11" bulletin pictures and describes Model 59, an instrument that acts as a variable frequency oscillator, an absorption wavemeter, an oscillating detector and a tuned absorption circuit detector. Measurements Corporation, Boonton, N. J.

RAWSON METERS

MULTIMETERS and REGULAR METERS
AC and DC types, high accuracy, multiple ranges.
2 microamperes to 1 ampere DC.
2 milliamperes to 3 amperes AC.

ELECTROSTATIC VOLTMETERS
Ranges 150-v. to 35,000-v AC or DC.
Resistance exceeds million megohms
Can measure static electricity.

FLUXMETERS
Laboratory and production measurements on magnets and magnetic circuits. Single push button return-to-zero.

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High sensitivities, low power factors.
New types soon to be announced.

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CHICAGO LOS ANGELES NEW YORK CITY

pany on the variety of instruments of their manufacture and applications of these instruments. The Esterline-Angus Co., Inc., P. O. Box 596, Indianapolis 6, Indiana.

O-364 **Thermowells.** 4-page 8½" × 11" Bulletin No. 11 pictures and describes thermowell assembly used in the petroleum and chemical industry when necessary to fabricate built-up wells for emergency uses and for pilot plant installations. E. W. Turner Electric Co., 6138-40 N. Beechwood St., Philadelphia 38, Pa.

O-365 **Packless-diaphragm Control Valves.** 4-page 8½" × 11" Bulletin No. 113 pictures, diagrams and describes the 3000 B series of the maker's packless bellows-sealed design for assuring leak-proof control valves in difficult and dangerous processes. Hammel-Dahl Co., 243 Richmond St., Providence 3, R. I.

O-366 **Time-cycle Controllers.** 12-page 8½" × 11" Bulletin C305 pictures and describes maker's newest development, the "Impulse-Sequence Time-Cycle Controller, Model C500," for simplification and flexibility in timing industrial process operations. The Bristol Company, Waterbury 91, Conn.

O-367 **Dew-point Recorder.** 2-page 8½" × 11" bulletin pictures and describes instrument for recording the moisture content of air or other atmospheres is a necessity. Povides a continuous record of humidity within a temperature range from —45°F. to room temperature. Surface Combustion Corp., Toledo, Ohio.

O-368 **Vibration Mountings.** 12-page 8½" × 11" Bulletin No. 106 pictures and describes the "Multi-plane" vibration mountings for the isolation of vibration through a greater range of frequencies regardless of the direction of disturbing forces. Lord Mfg. Co., Erie, Pa.

O-369 **Radio Test Equipment.** 12-page 8½" × 11" Catalog 5146-T lists and pic-

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Well groomed, easy-to-read label product for instructions, trade-marks, codes, identifying marks, etc. Topflight Tape Labels apply instantly on metal, glass, wood, etc.

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Inc.
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O-375 **Diaphragm-motor Control Valves.** 24-page 8½" × 11" Bulletin No. 500 introduces the new "700 Series" air-operated diaphragm motor control valve. Mechanical and flow characteristics are described together with the standard and special control applications. H. Belfield Co., Philadelphia, Pa.

O-376 **Speed Changers.** 1-page 8½" × 11" Bulletin describes and pictures miniature speed changers with speeds up to 20000 R. P. M. and torques up to 2 pound-inches for controls, instruments, experimental work and small power devices. Metron Instrument Co., 432 Lincoln St., Denver 9, Colorado.

O-377 **Power Analyzer.** 2-page 8½" × 11" bulletin pictures and describes Model 78, portable test laboratory for A. C. power measurement with A. C. ranges of 0-300 amperes, 0-600 volts and 0-300 min. to 240,000 watts. Niagara Electrical Instrument Co., 559 Ellicott St., Buffalo 3, N. Y.

O-378 **Pressure-analyzing Oscillograph.** 4-page 8½" × 11" Bulletin No. 109 pictures and describes "Hydraulscope" portable high-speed analyzer to record high-speed pressure phenomena in operation of hydraulic systems Aeroquip Corp., Jackson, Mich.

O-379 **Densitometer.** 4-page 6" × 9" bulletin pictures and describes "Photocolor" precision densitometer, a double photoelectric cell balanced electric circuit whose operation is not affected by fluctuations of line voltage or other electrical disturbances. National Photocolor Corp., 305 E. 43rd St., New York N. Y.

O-380 **Strainers.** 4-page 8½" × 11" Bulletin No. 224 pictures and describes the new "Type SY" strainer for pipe-line protection for steam, air, gas or liquid services from scale, dirt, sludge, etc. A. W. Cash Valve Mfg. Corp., Decatur, Ill.

O-381 **Moisture Tester.** 4-page 8½" × 11" Bulletin pictures and describes the "Steinlite Model 105 E" moisture tester for testing coarse products and the 40 gram "Steinlite" model for testing ground or powdered products. Seedburo Equipment Co., Chicago 6, Ill.

O-382 **Industrial Instruments.** 8-page 8½" × 11" Bulletin 394 describes "Dynalog" principle of industrial instrument construction. Instrument circuits are shown diagramatically and applications to temperature, humidity, pressure, flow, force, rpm, pH, etc., are given. The Foxboro Company, Foxboro, Mass.

O-383 **Flow Indicators.** 4-page 8½" × 11" Bulletin 18w pictures and describes Meaker's rotary-type, flapper-type and distillate-type high-pressure flow indicators. Schutte & Koerting Co., 12th & Thompson Sts., Philadelphia 22, Pa.

O-384 **Divided-circle Spectrometers.** 16-page 8½" × 11" Bulletin 157-74 describes and illustrates six models capable of angular measurements to various accuracies from one minute to one second. Industrial and educational applications are indicated. The Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.

O-385 **Wave-length Spectrometers and Monochromators.** 12-page 8½" × 11" Bulletin 158-74 describes six prism instruments, three for visible region, two with quartz optics for the ultraviolet and one with rock salt optics for the infrared. Optical diagrams and detailed specifications are shown. Also described are thermopiles and interference spectroscopes. The Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.

O-386 **Flexible Couplings.** 4-page 8½" × 11" Bulletin 200-C describes and pictures seven sizes from 1/16 hp. to 1 hp. and in a miniature of 1/50 hp. rating of Neoprene core flexible coupling for small-load applications. Lord Mfg. Co., Erie, Pa.

O-387 **Stifness Gage.** 6-page 8½" × 11" Bulletin No. 4506 describes and illustrates a light-weight, portable, electrically-energized instrument for numerically calculating the stifness of thin flexible materials up to ⅛" thick. Taber Instrument Corp., 111 Groundry St., North Tonawanda, N. Y.

O-388 **Surface Pyrometer.** 4-page 8½" × 11" Catalog No. 160 pictures and describes an all-purpose instrument with interchangeable extension arms and thermocouples for a quick method of determining surface and sub-surface temperatures for production and in the laboratory. Pyrometer Instrument Co., 103 Lafayette St., New York, N. Y.

O-389 **Cooling and Refrigeration.** 16-page 8½" × 11" catalog and price list pictures and describes twenty different instruments designed for use in the cooling and refrigeration field. Also outlines functions of automttic controls analyzed for this field. Minneapolis Honeywell Regulator Co., Minneapolis, Minn.

O-390 **BTU Indicator.** 4-page 8½" × 11" Bulletin No. 405-B-2 pictures and describes the "Coloroptic" BTU Indicator for the direct determination of the heat value of any kind of gas. Connelly, Inc., 1154 So. California Ave., Chictgo, Ill.

O-391 **Automatic Controllers.** 36-page 8½" × 11" Catalog No. 900E covers maker's standard automatic non-indicating controllers for temperature and pressure for the oil refining, textile, dairy, canning, refrigeration, rubber and other industries. C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn 5, N. Y.

O-392 **Radios and Electronic Equipment.** 72-page 7" × 10" Catalog Supplement 447 includes the latest listings on capacitors, resistors, transformers, coils, switches, microphones, speakers, tubes, testers and other essentials. Concord

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O-394 **pH Test Kit.** 6-page 3" × 7" folder describes test kit containing nineteen "Hydrion" pH test papers in eighteen plastic dispensers covering full range from pH 0.0 to pH 14.0 R. P. Cargille, 118 Liberty St., New York 6, N. Y.

O-395 **"The Capacitor."** 16-page 6" × 8" Vol. 12, No. 5 of this house organ features a reprint from *Electrical Manufacturing* entitled "Electronic Photoflash Units." Cornell-Dubilier Electric Corp., Hamilton Blvd., South Plainfield, N. J.

O-396 **Oscilloscope.** 2-page 8½" × 11" Bulletin pictures and describes the "Model 49" 5-inch oscilloscope and the "Model 41" 3-inch oscilloscope. Electronic Development Laboratory, 2655 W. 19th St., Chicago, Ill.

O-397 **Laboratory Furnace.** 2-page 8½" × 11" Bulletin pictures and describes furnace and accessories which permit conversion into a direct-fired oven furnace, a muffle for indirect heating or a pot furnace. Surface Combustion, Toledo, Ohio.

O-398 **Steam Equipment.** 12-page 3" × 9" folder pictures and lists a number of the maker's items for distribution, utilization and metering of steam, gases and liquids. American District Steam Co., North Tonawanda, N. Y.

O-399 **Toolmaker's Spotlight.** 1-page 8½" × 11" Bulletin pictures and describes the "Opti-Spot," a specialized shop light for dark, hard-to-illuminate work areas. The Benton Co., 351 So. La Brea Ave., Los Angeles 36, California.

O-400 **Printed Electric Circuit.** 2-page 8½" × 11" Bulletin pictures and describes the "Couplate," an assembly of two capacitors and two resistors bonded to a steatite ceramic plate, mutually connected by metallic silver paths printed and fired on the surface of a base plate. Centralab Div., of Globe Union, 600 E. Keefe Ave., Milwaukee 1, Wis.

O-401 **Relays.** 4-page 8½" x 11" brochure illustrates and describes ten "Amrecon" relays and two "Amrecon" switches, for electrical-equipment control. American Relay and Controls, Inc., 2555 Diversey Ave., Chicago 47, Ill.

O-402 **Flowmeter.** 12-page 8½" x 11" Bulletin 47-801 describes in detail, with a profusion of diagrams and photographs, the "Hays-Cochrane High Torque Mechanical Flow Meter." Orifices, flow nozzles and Venturi tubes are also described. The Hays Corporation, Michigan City, Indiana.

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